NASA SP-7009(03)

LASERS AND MASERS

A CONTINUING BIBLIOGRAPHY

WITH INDEXES

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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NASA SP-7009(03)

LASERS AND MASERS

A CONTINUING BIBLIOGRAPHY

WITH INDEXES

A Selection of Annotated References to Unclassified Reports and Journal Articles introduced into the NASA Information System during the period April, 1967–December, 1967

Scientific and Technical Information Division
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. JUNE 1968

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INTRODUCTION

What *Lasers and Masers* is

This publication is the third supplement to the continuing bibliography, *Lasers and Masers* (NASA SP-7009), and contains references to reports and journal articles announced in the NASA abstract journals during the period April 1967 through December 1967. 1177 references are included.

Previous bibliographies in this series are NASA SP-7009 (January 1962 through February 1965), NASA SP-7009(01) (February 1965 through April 1966), and NASA SP-7009(02) (April 1966 through April 1967).

Scope of Bibliography

References are included to all major studies associated with the research and development of lasers and masers. Emphasis is placed on laser and maser applications as they relate to ranging and communications systems, astronomy and optics, and metalworking. Fundamental studies of the physical and electronic properties, and the functioning and performance of lasers and masers are also cited.

Organization of Bibliography

The bibliography is arranged in Abstract and Index Sections. The Abstract Section contains bibliographic citations and informative abstracts for the references selected from *STAR (Scientific and Technical Aerospace Reports), IAA (International Aerospace Abstracts),* and *Aerospace Medicine and Biology* (NASA SP-7011). The *STAR* abstracts are listed first, followed by the *IAA* and the *Aerospace Medicine and Biology* abstracts. Each set of abstracts is arranged in ascending accession number order.

The Index Section contains two indexes, subject and personal author, in that order.

How to Use this Bibliography

Reports are referenced in the *STAR* Abstracts section. Published literature items are referenced in the *IAA* Abstracts and the *Aerospace Medicine and Biology* Abstracts sections. The subject index may be used to locate references to specific topics or technical areas; the personal author index may be used to locate references to reports or articles written by a particular individual.

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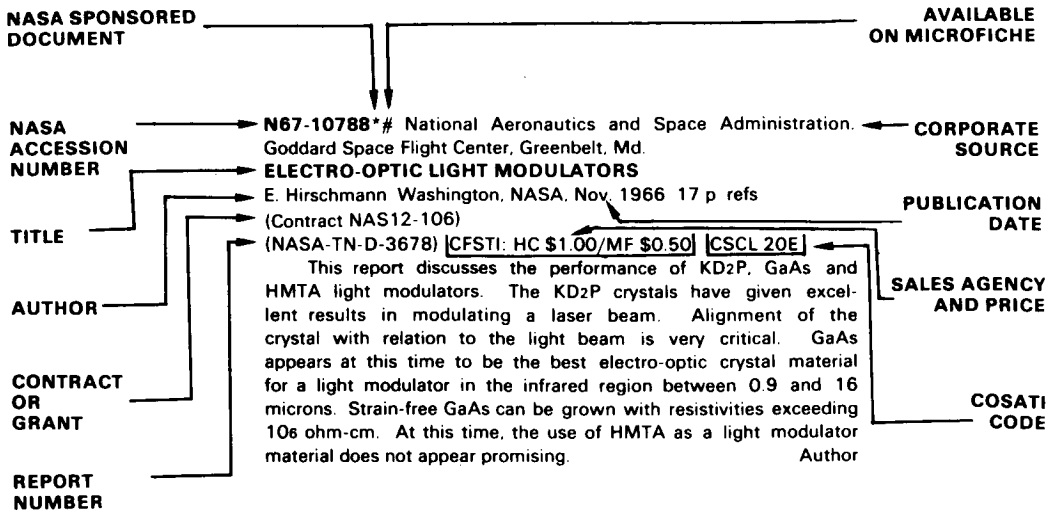
New York, N.Y. 10017

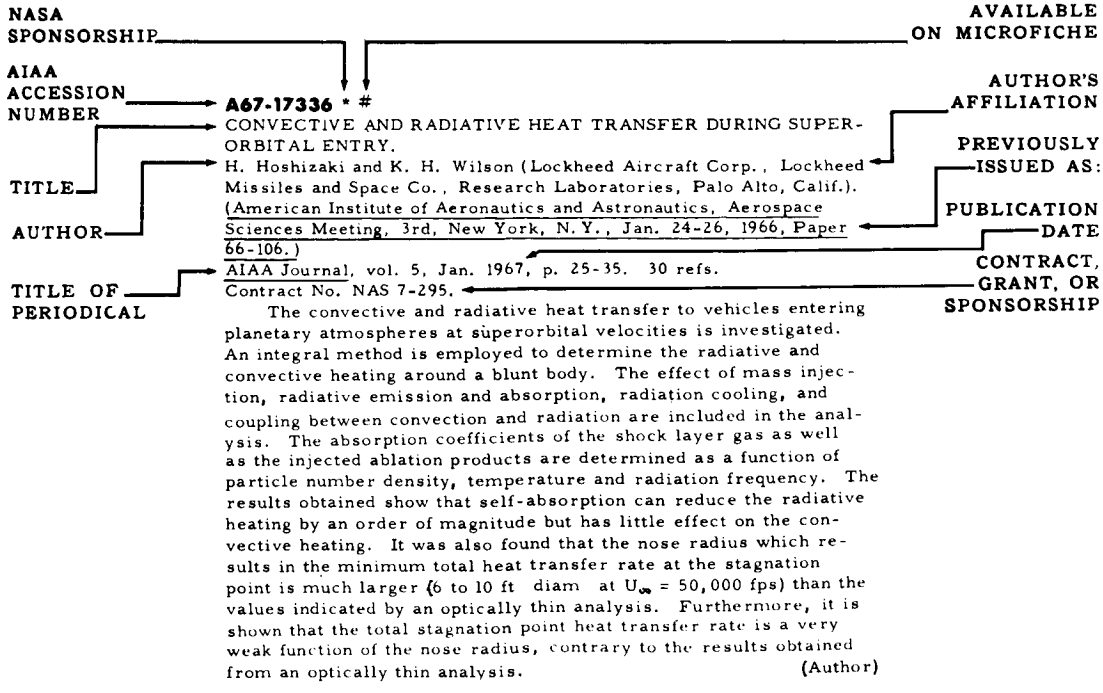
Aerospace Medicine and Biology References (A67-80000 Series)

Journal articles and books included in this section are available in libraries, where they may be borrowed or consulted.

TYPICAL *STAR* CITATION AND ABSTRACT



TYPICAL *IAA* CITATION AND ABSTRACT



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LASERS AND MASERS

a continuing bibliography JUNE 1968

STAR ABSTRACTS

N67-19461*# Arkansas Univ., Little Rock.
INVESTIGATION OF LASER PROPERTIES RELEVANT TO THE MEASUREMENT OF DIFFERENT PHYSICAL PARAMETERS Status Report, Period Ending 31 Dec. 1966
31 Dec. 1966 75 p refs
(Grant NsG-713)
(NASA-CR-82828) CFSTI: HC $3.00/MF $0.65 CSCL 20E

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1. HOLOGRAPHY: LASER INTERFEROGRAMS R. M. Jones p 1–4 (See N67-19462 09-16)
2. THE SORTING OF HOLOGRAPHIC INFORMATION FOR TRANSMISSION R. M. Jones p 5–8 (See N67-19463 09-23)
3. PULSED LASER HOLOGRAMS R. H. Gibbons p 9–13 (See N67-19464 09-16)
4. SCHLIEREN HOLOGRAPHY-RAY TRACING R. L. Bond p 14–18 (See N67-19465 09-16)
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7. DYNAMIC MEASUREMENTS: TRANSDUCER CALIBRATION V. E. Horn p 46–53 refs (See N67-19468 09-14)

N67-19462*# Arkansas Univ., Little Rock.
HOLOGRAPHY: LASER INTERFEROGRAMS
R. M. Jones *In its* Invest. of Laser Properties Relevant to the Meas. of Different Phys. Parameters 31 Dec. 1966 p 1–4 (See N67-19461 09-16) CFSTI: HC $3.00/MF $0.65

The effect of a schlieren field on the holographic reconstruction of a grating or of a recorded interference pattern was investigated to demonstrate the production of a zero or low-order interferogram from a higher order interferogram. Two collimated laser beams were brought together at an angle on a photographic plate, which recorded the interference lines formed. The plate was a high-order interferogram of the two beams. With the plate back in place in the beams, the same pattern was incident on the plate. The two interferograms in exact alignment produced a single dark or light band which was a zero-order interferogram. There was more than one fringe when the frequency of the lines was altered by changing the angle of the beams, or when the recorded interference pattern was tilted at a slight angle to that produced by the beams. The fringes were visible on the plate and as a projected pattern behind the plate. The angle of the two beams gave a line frequency of about 50 lines/mm. When a schlieren field was placed in either beam it became clearly visible. R.N.A.

N67-19464*# Arkansas Univ., Little Rock.
PULSED LASER HOLOGRAMS
Robert H. Gibbons *In its* Invest. of Laser Properties Relevant to the Meas. of Different Phys. Parameters 31 Dec. 1966 p 9–13 (See N67-19461 09-16) CFSTI: HC $3.00/MF $0.65

Work was conducted on improving pulsed laser holograms to obtain high quality holograms that can be reconstructed with gas lasers. The systems studied were set up using focusing optics to collimate and enlarge the beam coming from the ruby laser. Although first order reconstructions were obtained, the images were not distinguishable because the beam ionized the air at the point of focus and disrupted its coherence. A vacuum chamber was built to permit the beam to be focused in vacuo during collimation. A pinhole was used to spatially filter the beam during collimation. The vacuum chamber eliminated the problems of focusing the laser beam in air and successful holograms were obtained on both glass plate and aerial films. The reconstructed images could be distinguished, but the hologram image made on glass plate film was more distinct because of its higher resolving power. To obtain high quality ruby laser holograms, it is shown that consideration must be given to the laser coherence length and to the elimination of the laser's longitudinal and transverse modes. The best pinhole material is stainless steel foil 0.010-in thick. Pinholes 0.0005-in in diameter were obtained but they were destroyed with as few as ten laser firings. R.N.A.

N67-19468* Arkansas Univ., Little Rock.
DYNAMIC MEASUREMENTS: TRANSDUCER CALIBRATION
V. E. Horn *In its* Invest. of Laser Properties Relevant to the Meas. of Different Phys. Parameters 31 Dec. 1966 p 46–53 refs (See N67-19461 09-16) CFSTI: HC $3.00

The feasibility of the interferometer method of measuring extremely small oscillatory motions such as those associated with the calibration of miniature accelerometers was demonstrated with a Michelson interferometer and a laser source. The lower limit of such measurement will finally be set by the noise created at the laser source. The best source available has approximately 1/4 of 1% amplitude modulation short term. This would allow a measurement of 20 angstroms with better than two-to-one signal-to-noise ratio which should be satisfactory for accurate measurement. However, there are a number of drift and stability considerations that must be understood before the noise of the laser becomes the limiting factor. R.N.A.

N67-19709# Ballistic Research Labs., Aberdeen Proving Ground, Md.
DESIGN OF AN AIRBORNE LASER BEAM PROFILE MONITOR
Morgan T. Reedy Aug. 1966 18 p ref
(BRL-TN-1625; AD-642163) CFSTI: HC $3.00/MF $0.65

A system for sensing and recording the profiles of a CW laser beam on a propagation path of approximately 30 degree elevation and 3 miles slant range was developed. The parameters of interest are beam dispersion and energy density fluctuations due to turbulence effects. Author (TAB)

N67-19728# Columbia Univ., New York. Plasma Lab.
CONTROL OF METASTABLES BY OPTICAL METHODS AND ITS APPLICATION TO GASEOUS LASERS Final Report, 1 Jun. 1963–1 Oct. 1966
Thomas C. Marshall and Bertram Pariser 1 Oct. 1966 33 p refs
(Contract Nonr-266(93); Proj. Defender)
(Rept.-26; AD-642710) CFSTI: HC $3.00/MF $0.65

Experimental work on the gaseous electronics of the He-Ne laser is reviewed. Application of optical pumping techniques for the control of He and Ne metastable populations are described and applied to the gas laser. Author (TAB)

N67-19806# Ballistic Research Labs., Aberdeen Proving Ground, Md.
A NUMERICAL SOLUTION TO AN ABLATION PROBLEM WITH POSSIBLE LASER APPLICATIONS
James G. Faller Oct. 1966 28 p refs
(BRL-R-1342; AD-644734) CFSTI: HC $3.00/MF $0.65

The problem of an ablating solid of limited extent under an applied non-uniform heat input is solved numerically, and the solution is compared in certain limiting cases with results from the exact analytical equations. Further, the usefulness of this model in predicting the depth of hole made in materials by a laser beam is explored. Author (TAB)

N67-19979# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LASER LIGHT ADVANCES IN AVIATION
Yen You Chin 23 Sep. 1966 16 p Transl. into ENGLISH from Hang K'ung Chih Shih, no. 7, 1964 p 7–12
(FTD-TT-65-361; AD-643959) CFSTI: HC $3.00/MF $0.65

The article examines laser light advances in the field of aviation and its applications in communications, searching, tracking and interception. TAB

N67-20005# Union Carbide Corp., East Chicago, Ind. Electronics Div.
PRODUCTION ENGINEERING MEASURE FOR RUBY LASER RODS Quarterly Progress Report, 1 Apr.–30 Jun. 1966
M. K. Towne, O. H. Nestor, and L. R. Rothrock 30 Jun. 1966 34 p
(Contract DA-36-039-AMC-06168(E))
(QPR-4; AD-643859) CFSTI: HC $3.00/MF $0.65

Additional multi-variable runs have been completed in the process engineering studies. These runs have established optimum values for process parameters for ruby growth in a furnace chamber of specific size. It was shown that, contrary to original expectation, the pulsed powder feed system is preferred over continuous feed. A description of the system and procedures used in active laser tests is presented. The results of active and passive tests on all engineering samples are summarized and discussed. Author (TAB)

N67-20154# Stanford Univ., Calif. Linear Accelerator Center.
SLAC ALIGNMENT SYSTEM
W. B. Herrmannsfeldt Oct. 1966 17 p refs Presented at LSAL Linear Accelerator Conf., Los Alamos, N. Mex., 10–13 Oct. 1966
(Contract AT(04-3)-400)
(SLAC-PUB-222; CONF-661021-15) CFSTI: HC $3.00/MF $0.65

A review of the operating experiences with the laser alignment system of the two-mile linear accelerator is presented. It includes discussions of some of the special alignment techniques used prior to the initial start up of the accelerator. Author (NSA)

N67-20183# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LASER
Ang-ju Chu 21 Nov. 1966 20 p Transl. into ENGLISH from Tien Tzu Chi Shu (Communist China), no. 3, 1964 p 24–28
(FTD-TT-65-1453; TT-67-60190; AD-643606) CFSTI: HC $3.00/MF $0.65

The similarities between light and electromagnetic waves are compared. The laser oscillator is described along with laser radiation. The use of the laser in space research, communication, medicine, photography, etc., is described. The ruby laser and a gaseous state laser are described. Author (TAB)

N67-20348# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering.
EFFECTS OF PRESSURE ON A SEMICONDUCTOR LASER RADIATION
Jose Ellis Ripper Filho (Ph.D. Thesis) 19 Sep. 1966 146 p refs
(Contracts Nonr-1841(51); DA-31-124-ARO(D)-92)
(TR-5; AD-642514) CFSTI: HC $3.00/MF $0.65

The results of the relativistic APW calculation of the band structure, momentum matrix elements and deformation potentials of the lead salts are used to calculate the effects of constant pressure on lasers made of these materials. Behavior of the frequency, polarization and relative gain of these lasers are calculated for several dopings, and injection levels, when isotropic and uniaxial pressures are applied. The effect of small dynamic pressure on semiconductor lasers is analyzed, resulting in a frequency modulation of the laser radiation. An experiment confirming this analysis was performed. A 2 Mc/s frequency modulation was introduced into a cw GaAs injection laser with an ultrasonic wave. This modulation was then detected with the use of a Fabry-Perot interferometer. A theoretical analysis of the limitations of the method of modulation demonstrated above was carried out with a regard to its device applications. Author (TAB)

N67-20379*# Sylvania Electric Products, Inc., Mountain View, Calif.
FREQUENCY STABILIZED GAS LASER Final Summary Engineering Report, 17 Jun. 1966–17 Feb. 1967
R. S. Reynolds, J. D. Foster, A. A. Kamiya, and A. E. Siegman 17 Feb. 1967 84 p refs
(Contract NAS8-20631)
(NASA-CR-82981) CFSTI: HC $3.00/MF $0.65 CSCL 20E

To provide long-term stabilization, a technique which allows a CO_2 laser, operating at a wavelength near 10.6 microns, to be stabilized with respect to a nonregenerative CO_2 amplifier was chosen. This technique is analyzed and shown to be capable of providing a frequency stability of about 1 part in 10^{10} using presently available 10-micron detectors. Factors affecting the absolute stability of the CO_2 amplifier frequency are discussed with the conclusion that the pressure variations within the amplifier tube may be the limiting factor for long-term frequency stability. A detailed design is presented for a CO_2 laser system capable of providing greater than 1/2 watt of 10.6 micron radiation, frequency stabilized to within 3 kHz. Techniques for ensuring single-frequency operation in the CO_2 laser without degradation in power output are also discussed. Author

N67-20404* Massachusetts Inst. of Tech., Cambridge.
A STUDY OF THE ATMOSPHERIC EFFECTS ON INTENSITY SPATIAL AND TEMPORAL PROPERTIES AT 6328A
James Eugene Roberson (M.S. Thesis) Feb. 1967 28 p refs
(Grant NsG-334)
(NASA-CR-83052) CFSTI: HC $3.00 CSCL 20F

The effects of turbulence on the intensity of a collimated beam transmitted through the atmosphere are considered. Focused on are the intensity statistics at a point, the spatial intensity correlation function, and the time crosscorrelation function of intensity. Expected theoretical results are examined, and results of experimental studies over a 4,000 meter atmospheric channel are presented. Author

N67-20449 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MOSCOW UNIVERSITY HERALD. SERIES III. PHYSICS, ASTRONOMY
7 Dec. 1966 13 p refs Transl. into ENGLISH from Vestn. Mosk. Univ., Ser. III: Fiz.-Astron. (Moscow), vol. 20, no. 5, 1965 p 89–92
(FTD-HT-66-276; TT-67-60191; AD-643625) CFSTI: $3.00

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1. CIRCUITS OF PARAMETRON FREQUENCY DIVIDERS V. P. Komolov p 1–5 refs (See N67-20450 10-09)
2. NARROWING OF EMISSION BAND OF A RUBY LASER WITH A COMPLEX RESONATOR F. A. Korolev and S. M. Mamedzade p 6–7 ref (See N67-20451 10-16)

N67-20450 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CIRCUITS OF PARAMETRON FREQUENCY DIVIDERS
V. P. Komolov *In its* Moscow Univ. Herald. Ser. III. Phys. Astronomy 7 Dec. 1966 p 1–5 refs (See N67-20449 10-16) CFSTI: HC $3.00

The proposed divider effectively filters the undesirable pump frequency at the output (up to 30 dB), preserves parametric oscillations over a wide range of frequencies and has the possibility of working with extremely low values for the required energy and with high efficiency (up to 90%) in so far as the parametron works in the zone of inverse voltage of the diode, and therefore it possesses very great input resistance. The parametric generator had two outputs, one for connecting the following parametron and the other for oscillographic control and measurements. A conclusion is drawn that the parametron cascade frequency dividers do not present complexities and are stable and simple in adjustment. Simultaneously with such intermediate amplification circuits, a practical design for frequency dividers with a sufficiently high multiplicity division factor is possible. The cascade parametron divider is a system with many stable conditions distinguished by a stationary oscillation phase read off from the pumping phase. Author

N67-20451 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
NARROWING OF EMISSION BAND OF A RUBY LASER WITH A COMPLEX RESONATOR
F. A. Korolev and S. M. Mamedzade *In its* Moscow Univ. Herald. Ser. III. Phys. Astronomy 7 Dec. 1966 p 6–7 ref (See N67-20449 10-16) CFSTI: HC $3.00

The feasibility of creating multiple interference light filters, consisting of two simple interference filters with almost equal effective thicknesses, is shown. One can fade out the maxima of the passage of each of the filters. By using this principle, a narrowing of the band of a ruby laser's radiation with a multiplex resonator may be obtained. Author

N67-20508# American Optical Co., Southbridge, Mass. Research Div.
PREPARATION OF PLATINUM-FREE LASER GLASS
Semiannual Technical Report, 1 Jan.–31 Jul. 1966
Richard F. Woodcock, George A. Granitsas, and Carl G. Silverberg 31 Jul. 1966 18 p
(Contract Nonr-4656(00); ARPA Order 306-62; Proj. Defender)
(SATR-4; AD-643259) CFSTI: HC $3.00/MF $0.65

The purpose of this project is to produce high optical quality laser glass free of platinum particles. It was found that glass melted under an inert atmosphere in a platinum crucible contained no detectable platinum particles. Methods to prevent evaporation of various oxides that caused inhomogeneities in the glass were investigated. Data was accumulated to determine the effect of time, temperature, and atmosphere on the weight loss of platinum and alloying of platinum with ingredients in glass. A parallel approach to this problem is the melting of glass in a high purity all ceramic system. Modifications of the system, based on results of the initial runs, have been completed. Failure of a high temperature sprinkler head during testing of the furnace has seriously delayed this phase of the project. Author (TAB)

N67-20561# Edgerton, Germeshausen and Grier, Inc., Bedford, Mass.
STUDY OF A MULTI-PULSE LASER RANGE FINDER
Sumner Ackerman and Thomas S. Morrison 20 Oct. 1966 62 p refs
(Contract AF 19(628)-5516)
(EG&G-B-3434; AFCRL-66-755; SR-2; AD-642447) CFSTI: HC $3.00/MF $0.65

A programmed multi-pulse optical radar range finder is analyzed. An experimental multi-pulse laser has been developed and its characteristics are described. If the target is optically 'smooth', or is well resolved by the receiver, the multi-pulse range finder has an effective power gain slightly less than its output energy gain when the noise level is low and the detection probability is high. The useful energy gain of a ruby laser due to multi-pulsing was experimentally measured as about 8 db. Under the conditions of geodetic satellite ranging, the target is generally optically 'rough' in the extreme; then the multi-pulse range finder has a power gain of from 10 db to over 25 db, depending on the relative transmitter efficiencies and the acceptable detection probability. This significant increase in the advantage of the multi-pulse system results from the detection statistics that are valid when signal scintillation due to the target is present. Author (TAB)

N67-20681# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LASERS ON A CONVEYER
L. Lisovskiy and M. Stel'makh 27 Sep. 1966 6 p Transl. into ENGLISH from Izv. (Moscow), 29 Apr. 1965 p 4
(FTD-HT-66-228; AD-644047) CFSTI: HC $3.00/MF $0.65

Presently started is the manufacture of four types of gas lasers which give irradiation in visible and infrared areas of the spectrum with a power of fractions of a milliwatt to 15 milliwatts. Semiconductor quantum generators are compact, wheir weight is considerably lower, than other types of optical quantum generators, but the require cooling with liquid nitrogen. Gaseous and semiconductor lasers pertain to the category of 'little power' ones. Much more intensive is the beam of light given by lasers with solid active substance, for example, ruby or special glass. TAB

N67-21016# Sydney Univ. (Australia). School of Physics.
WILLS PLASMA PHYSICS DEPARTMENT Eleventh Six-Monthly Progress Report, 1 Jan–30 Jun. 1966

30 Jun. 1966 12 p refs Sponsored by Australian Inst. of Nucl. Sci. and Eng. and Nucl. Res. Found.
(NP-16321)

Brief summaries of plasma research at Sydney are presented. The research includes work on plasma sources, compressional wave studies, large amplitude Alfvén waves, surface microwave relfections, longitudinal wave propagation, lasers, and the magnetic field of the moon. NSA

N67-21344# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A METHOD OF SUMMING THE POWER IN LASERS WITH EACH OF THEM WORKING COHERENTLY

M. Ye. Zhabotinskiy and G. A. Vasneva 9 Sep. 1966 6 p Transl. into ENGLISH from Russian Patent No. 172357 (Appl. No. 830263/26-25, 11 Apr. 1963) 2 p
(FTD-HT-66-107; AD-644042) CFSTI: HC $3.00/MF $0.65

The method of summing the power in lasers when each of them is working coherently is different in that to increase the power and directivity of emission of the lasers, part of the beam is selected, sequentially distributed between neighboring lasers and, to scan the main lobe of the emission diagram, it is sent to phase inverters placed in the output beams of the lasers. Author (TAB)

N67-21422# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE CHARACTERISTICS OF INDUCED COMBINED DISPERSION IN BENZENE

V. L. Broude, L. P. Vil'chyns'ka et al 27 Sep. 1966 6 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 9, no. 9, 1964 p 1031 1032
(FTD-HT-66-174; AD-644009) CFSTI: HC $3.00/MF $0.65

An induction combination dispersion was obtained in purified benzene, which was contained in the resonator of a ruby laser, and the characteristics of its origin were investigated. TAB

N67-21879# Army Medical Research Lab., Fort Knox, Ky.

ABERRANT CORNEAL EPITHELIAL CELLS PRODUCED BY RUBY LASER IRRADIATION

W. H. Parr and Robert S. Fisher 31 Oct. 1966 31 p refs
(AMRL-698; AD-645452) CFSTI: HC $3.00/MF $0.65

Rat corneas were exposed to either 4 joules per sq cm or 8 joules per sq cm and were harvested at varying times following laser exposure. Corneal whole mounts were evaluated for changes in either the differential mitotic cell count or the mitotic index. Ruby laser radiation (6,943 A) produces aberrations in the corneal epithelium of the rat. At 8 joules per sq cm both interphase cells and cells in active mitosis were obviously altered. At 4 joules per sq cm aberrant corneal epithelial cells became apparent immediately after laser irradiation, and some were still present 30 days later. The mechanism by which laser radiation alters the cornea remains obscure. Author (TAB)

N67-22535# General Electric Co., Philadelphia, Pa. Missile and Space Div.

FORMATION OF CRYSTALLINE FILMS BY LASER EVAPORATION

P. D. Zavitsanos and W. E. Sauer Dec. 1966 20 p refs
(R66SD66; AD-804354) CFSTI: HC $3.00/MF $0.65

Using a pulsed ruby laser for the evaporation of germanium and gallium arsenide, it was observed that crystalline films of both materials can be prepared on unheated substrates of glass, sodium chloride and calcium fluoride. In the case of gallium arsenide, congruent deposition was observed. The films were 500 A–1000 A thick and were studied by reflection and transmission optical microscopy, as well as by electron diffraction. Author (TAB)

N67-22537# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.

NOISE SOURCES DESCRIBING QUANTUM EFFECTS IN THE LASER OSCILLATOR

Herman J. Pauwels 1 Dec. 1966 117 p refs
(Contract DA-36-039-AMC-03200(E))
(TR-453; AD-646321) CFSTI: HC $3.00/MF $0.65

Quantum noise in the laser means those properties of the laser output that are caused by the quantum nature of the electromagnetic field and of the material systems and reservoirs with which it interacts. It is shown that a fully quantum-mechanical treatment of the laser can be formulated in a noise-source formalism, for which the noise sources are operators. A definition is given for the Gaussian character of operators in an appropriate ensemble, and it is shown that the noise sources for the laser are Gaussian. Special laser models are treated. The first model requires that the relevant relaxation time constants of the material be much smaller than those of the field; the second model drops this restriction. The final operator equations are solved by means of a linearization approximation that is only justified for operation points sufficiently above threshold. The first model takes the quantum nature of the field above threshold (or equivalently the commutator of certain noise-source operators) consistently into account; the second model neglects these quantum effects. The results are compared with the predictions of a semiclassical theory in which classical equations contain noise sources that correctly represent properties of the field below threshold. Author (TAB)

N67-22576# Library of Congress, Washington, D. C. Aerospace Technology Div.

PARAMETRIC OSCILLATION AND AMPLIFICATION AT OPTICAL FREQUENCIES Surveys of Foreign Scientific and Technical Literature

Charles Shishkevish 4 Nov. 1966 29 p refs
(ATD-66-131; TT-67-60545; Rept.-4; AD-645995) CFSTI: HC $3.00/MF $0.65

The report is based on Soviet open sources published 1962-1966 and one Western source published in 1966. The fourth in a series, the present report summarizes Soviet research on parametric amplification of light. The Introduction presents background information on this research and includes a summary of the five sections in this report. The sections are: I. One-dimensional parametric amplification; II. Two-dimensional parametric amplification; III. Tunable coherent parametric oscillator operating at optical frequencies; IV. Theoretical analysis (A. Derivation of the basic equation and formulation of the boundary conditions; B. Analytical solutions for the transient regime in the cavity in the constant pump field approximation; C. Analytical solutions for the steady-state regime in the cavity; D. Numerical solutions for the transient and steady-state regimes in the cavity); V. Parametric amplification and oscillation in a medium pumped by coherent molecular vibrations excited by SRS. Author (TAB)

N67-22687# Navy Underwater Sound Lab., New London, Conn.

EXAMINATION OF SAFETY PROBLEMS ASSOCIATED WITH USL FIELD LASER OPERATIONS

Ralph J. Polley 14 Nov. 1966 27 p refs
(USL-772; AD-646009) CFSTI: HC $3.00/MF $0.65

The report discusses the eye safety problem created by projected field operations with a pulsed ruby laser. Information is presented to (1) support the establishment of 2 x 10 to the minus 9th power joules as a conservative value for the amount of laser energy tolerable at the eye pupil, (2) relate this threshold value to the laser beam characteristics and atmospheric effects involved in the USL experiments, and (3) describe the particular range geometry. Finally, procedures to ensure safe field operation are recommended. Author (TAB)

N67-22727# Honeywell, Inc., Hopkins, Minn. Corporate Research Center.

MECHANISMS OF LASER-SURFACE INTERACTIONS Semiannual Report

J. F. Ready and E. Bernal G. Dec. 1966 85 p refs
(Contract DA-18-001-AMC-1040(X))
(AD-645473)

This report extends earlier measurements on particle emission produced when approximately 50 megawatts/sq cm pulses of radiation from a Q-switched ruby laser are absorbed at metal surfaces. Ion emission from carbon targets includes (Li6)(+), (Li7)(+), C(+), CH3(+), H2O(+), Na(+), and K(+) ions with energies up to 540 ev. Emission from single crystalline nickel targets includes ion species not observed before in this work, i.e., Na(++) and H2(+). Work using a quadrupole mass spectrometer to study neutral molecule emission has also been extended to carbon targets, which yield results similar to other target materials, and additional confirming work on the presence of high energy neutral molecules has been performed. Equipment under construction for measurement of the angular distribution of the ion emission is described. The expansion of the laser produced gas and resulting particle fluxes at a distance from the surface are discussed. Author (TAB)

N67-22838*# National Aeronautics and Space Administration, Washington, D. C.

THE "BLEACHING" EFFECT IN ZnS(Co) CRYSTALS UNDER THE INFLUENCE OF EXTREMELY LARGE PULSES OF A RUBY LASER [EFFEKT "PROSVETLENIYA" V KRISTALLAKH ZnS(Co) POD DEYSTVIYEM GIGANTSKIKH IMPUL'SOV RUBINOVOGO OPTICHESKOGO KVANTOVOGO GENERATORA]

L. N. Galkin Apr. 1967 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 170, no. 2, 1966 p 315–316
(NASA-TT-F-480) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The transmission spectrum of cobalt-doped $N_{Co}=2\times10^{18}$ cm^{-3}) zinc sulfide crystals (1 mm thick) under the effect of a high-intensity ruby laser radiation was investigated at 694 mμ. The results indicate that 50% "bleaching" was attained at an incident intensity of approximately 50 Mw/cm^2, in a process during which a considerable portion of the Co^{2+} ions were excited from the $^4A_2(F)$ state to the $^4T_1(P)$ state. The relaxation time of the inverted transition was found to be high, $\tau=1\cdot10^{-9}$ sec, assuming $\sigma=1.6\cdot10^{-17}\,cm^{-2}$. This indicates that only a negligible number of ions remains in the the metastable $^4T_2(F)$ state, transition from which into the lower $^4A_2(F)$ state is radiative and requires tens of μsec. Thus, the $^4T_1(P) \rightarrow {}^4A_2(F)$ and $^4T_2(F) \rightarrow {}^4A_2(F)$ transitions remain quasi-independent when the Co ions are exposed to short optical pulses. Author

N67-23044# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.

NOISE PROPERTIES OF MICROWAVE MASER OSCILLATORS

Sergej Dmitrevsky Jul. 1966 98 p refs
(Contract Nonr-1866(16))
(TR-504; AD-643230) CFSTI: HC $3.00/MF $0.65

Rate equations describing transient behavior of the photon number of a maser oscillator exhibit damped sinusoidal solutions if longitudinal relaxation times are sufficiently long. The resonant nature of the transient is reflected in the shape of the noise power spectrum of the oscillator. The level of the noise can be described in terms of correlation functions satisfying differential equations. The form of the solutions of these equations allows one to interpret the oscillator noise in terms of a shot effect of the photon number and level populations. Experimental verification of the theoretical behavior has been carried out on a series of ruby microwave masers. The results obtained have been applied to establish limits of the sensitivity of ESR spectrometers utilizing maser oscillators. Author (TAB)

N67-23449# Library of Congress, Washington, D. C. Aerospace Technology Div.

FOREIGN SCIENCE BULLETIN, VOLUME 3, NUMBER 2

Feb. 1967 41 p refs Sponsored by DOD
CFSTI: HC $3.00/MF $0.65

Papers are presented covering these areas: a 37 Gc quartz maser using double inversion; large thermal radiation detectors; synthesis, structure, and properties of ferroelectric and antiferroelectric A_2BO_3 and ABO_3 compounds; thermostable fibers; controlling the properties of polymers; and space biology and medicine reviews on the effect of electromagnetic and magnetic fields on the central nervous system, and on wind generated sea wave are also given along with a series of abstracts from radiobiology papers. C.L.W.

N67-23794*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

GAS DENSITY MEASUREMENTS USING LIGHT SCATTERING

Stuart L. Seaton Washington, NASA, Apr. 1967 27 p refs
(NASA-TN-D-3895) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Experiments are described and results discussed for measuring gas density by means of laser light scattered by gases. Rayleigh theory is confirmed for the experimental conditions encountered. Polarizabilities experimentally obtained agree satisfactorily with those from other sources based on refractive indices of the test gases. It is concluded that the feasibility of the method has been established. Author

N67-23843# University of Southern Calif., Los Angeles.

QUANTUM ELECTRONICS

W. H. Louisell *In its* [Solid State, Appl. Electromagnetics and Plasmas, and Inform. Sci.] 30 Sep. 1966 p 60 77 refs (See N67-23841 12-26)
(Grant AF-AFOSR-496-66)

A dynamic correspondence was set up between the density operator of an electromagnetic field and an associated classical function for a laser in which all atomic decay rates were faster than photon rates. The resulting associated classical function satisfied a Fokker–Planck type equation and was reduced to a rotating-wave van der Pol oscillator. Quantum electronic techniques were also applied to investigate ionic cross-relaxation effects in neodymium–glass oscillators by injecting light into the laser medium. The diagram for a narrowband radiation source located in the laser feedback path of the broadband laser was used to obtain a typical 100 Å band emission for a pumped neodymium–glass laser with neodymium yttrium garnet as narrowband source. G.G.

N67-23935# Westinghouse Electric Corp., Baltimore, Md.

VERSATILE LASER SIGNAL SOURCE Final Report, 1 Jun. 1965–15 Apr. 1966

I. T. Basil 15 Apr. 1966 52 p
(Contract DA-01-021-AMC-12095(Z))
(AD-645364) CFSTI: HC $3.00/MF $0.65

The fabrication and testing of a neodymium-doped glass laser oscillator-amplifier device is described, and test results and operating and maintenance information are presented. Author (TAB)

N67-23961# Library of Congress, Washington, D. C. Aerospace Technology Div.

FOREIGN SCIENCE BULLETIN, VOLUME 3, NO. 1

Jan. 1967 66 p refs

CONTENTS:

1. MICROWAVE ELEMENTS BASED ON AVALANCHE-TRANSIT DIODES S. Hibben p 1–9 refs (See N67-23962 12-09)

N67-23963# Library of Congress, Washington, D. C. Aerospace Technology Div.
RARE-EARTH ELEMENT CHELATES AS ACTIVE LASER MATERIALS
John Kourilo *In its* Foreign Sci. Bull., Vol. 3, No. 1 Jan. 1967 p 10-20 refs (See N67-23961 12-23)

Soviet research studies conducted in 1965 on the rare-earth element chelates and their adducts with organic bases were reviewed from the viewpoint of their pertinence to active laser materials. The impression was gained that effort in the area of the rare-earth element chelate-base lasers was concentrated on the β-diketonates of the aromatic series and their adducts, especially those of europium. This effort contributed to the development of a liquid laser system using europium tetrakis (-benzoylacetylacetonato) piperidinium as the active material. Research on the rare-earth element β-diketonates of the heterocyclic series, especially on thenoyl trifluoroacetyl acetonates and its adducts, was pursued at an accelerated rate. Author

N67-24312# Library of Congress, Washington, D. C. Aerospace Technology Div.
FOREIGN SCIENCE BULLETIN, VOLUME 3, NUMBER 3 Monthly Review of Selected Foreign Scientific and Technical Literature
Mar. 1967 127 p refs Sponsored by DOD
CFSTI: HC $3.00/MF $0.65

CONTENTS:

N67-24316# Library of Congress, Washington, D.C. Aerospace Technology Div.
THE GAS LASER IN A MAGNETIC FIELD
Yuri Ksander *In its* Foreign Sci. Bull., Vol. 3, No. 3 Mar. 1967 p 33-64 refs (See N67-24312 12-23)

A more comprehensive theoretical understanding of laser electrodynamics is gained through studies of the effect of the magnetic field on the operation of a gas laser. Research in this area is also valuable to the applied physicist in search of solutions to such problems as frequency tuning and stabilization, and the escalation of the laser output power. The Soviet works reviewed are strongly theoretical, giving little emphasis to applications. Author

N67-24364# United Aircraft Corp., East Hartford, Conn. Research Labs.
RESEARCH INVESTIGATION OF LASER LINE PROFILES Semiannual Report, 1 Aug. 1966–31 Jan. 1967
Anthony J. De Maria, George L. Lamb, Jr., and David A. Stetser 27 Feb. 1967 40 p refs
(Contract N00014-66-C0344; ARPA Order 306; Proj. Defender)
(F-920479-2; AD-647614) CFSTI: HC $3.00/MF $0.65

Some aspects of the theory of a gas laser recently developed by W. E. Lamb, Jr. are recast in a form which more fully displays the role played by the particle dynamics. The Wigner distribution function is used to derive kinetic equations which govern the external center of mass motion of the two-level system as well as their internal dynamics. The effect of long range forces is discussed by treating the collision integral in a manner similar to that employed in plasma kinetic theory. A modification in the criterion for the existence of a dip in the output is obtained. It is also shown that effects due to long range forces are most noticeable at long optical wavelengths and when there is a large difference between the lifetimes of the two laser levels. The experimental system for measuring the line profile of a dc excited argon laser was designed, constructed, and made operative. Preliminary data on the Lamb Dip of an argon ion laser was obtained as a function of pressure and excitation. Author (TAB)

N67-24376# Florence Univ. (Italy).
MODE SELECTION PROPERTIES OF A MANY-ELEMENT LASER
R. Pratesi and L. Ronchi-Abbozzo Oct. 1966 57 p refs
(Contract AF 61(052)-871)
(SR-4; AFCRL-67-0066; AD-647773) CFSTI: HC $3.00/MF $0.65

A theoretical analysis is carried out of the mode-selection properties of a Many Element Laser consisting of N like elements of active material separated by lossless unlike air-gaps. The gaps are assumed to be sufficiently narrow to present frequency-independent transmission and reflection coefficients. A comparison with an unsegmented resonator, with equal total length of active material and equal end-face reflectivities is performed, by using the generalized Tang Statz and de Mars theory. Experiments of mode selection in a MEL with N = 5, 7 and 10 like elements are reported. Author (TAB)

N67-24379# Sylvania Electric Products, Inc., Mountain View, Calif. Electronic Defense Labs.
TECHNIQUES FOR SUPER-MODE OSCILLATION Interim Engineering Report, 1 Oct.–31 Dec. 1966
Russell Targ, D. E. Caddes, J. D. Foster, J. M. French, and L. M. Osterink 31 Dec. 1966 38 p refs
(Contract AF 33(615)-2884)
(IER-6; AD-645045) CFSTI: HC $3.00/MF $0.65

An evaluation was made of the FM stabilization system, making use of the odd harmonic FM beats to achieve absolute frequency stabilization of the FM carrier with respect to the center of the atomic gain profile. The system is able to provide stabilization of better than 1 part in 10 to the 8th power on a long-term basis with no net drift in the FM spectrum. The FM laser not only can be used to give stabilized single-frequency light, but also has other applications. In particular, the FM laser without stabilization is much more suitable for use as an optical carrier than is a free-running laser. The FM process couples the modes of the laser, reducing the low-frequency noise resulting from mode competition. The GaAs laser offers the possibility for the direct production of an FM laser without the need for introducing any additional material inside the laser cavity. A population inversion leading to gain and oscillation is created in GaAs by direct current excitation. Two ways of creating the time-varying component in the materials index of refraction which is the necessary condition for FM oscillation are by the electro-optic and photo-elastic effects. TAB

N67-24488# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN RESULTS OF COMPARING OKG ON A RUBY WITH PLANE PARALLEL AND CONFOCAL RESONATORS [NEKOTORYYE REZUL'TATY SRAVNENIYA OKG NA RUBINE S PLOSKOPARALLEL'NYM I KONFOKAL'NYM REZONATORAMI]

N. A. Sventsitskaya and L. D. Khazov 12 Dec. 1966 9 p refs Transl. into ENGLISH from Zh. Prik. Spektroskopii, Akad. Nauk Belorussk. SSR (Minsk), v. 4, no. 4, 1966 p 345–347

(FTD-HT-66-523; TT-67-61114; AD-647717) CFSTI: HC $3.00/MF $0.65

An experimental comparison of energy and of the radiation angle for lasers with plane and confocal mirrors was made. The radiation energy in the confocal resonator is 1.7 times greater than for the plane resonator. The angle of divergence of the radiation after compensation of the spherical component is 3.5 times greater, and the axial beam brightness is by an order less than for the plane resonator. Besides, for a confocal resonator more uniform energy distribution is observed, the time-dependence of the radiation of quasi-dependence pf the radiation of quasi-continuum character with superimposed regular oscillations is observed. Author (TAB)

N67-24581 Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Oberpfaffenhoffen (West Germany).

REMARKS TO THE RINGLASER AND ITS USE [BEMERKUNGEN ZUM RINGLASER UND SEINER ANWENDUNG]

F. Malota Jan. 1967 53 p refs In GERMAN; ENGLISH summary

(DLR-Mitt.-67-01) CFSTI: HC $3.00/MF $0.65

The theory of the SAGNAC-experiment is treated in terms of classical physics. The performances of a ring interferometer and a ring laser are presented and an attempt is made to explain the basic difference between the two. The effects which limit the performance of a ring laser are described. The realizable measurement range of the angular velocity and the influence of apparatus parameters on the ring laser performance are discussed. Author

N67-24771# Stanford Research Inst., Menlo Park, Calif.

LIDAR-RADAR LOWER ATMOSPHERIC OBSERVATIONS Final Report, 1 Apr.–14 Nov. 1966

William Viezee and John Oblanas 14 Dec. 1966 65 p refs

(Contract AF 19(628)-5976)

(AFCRL-67-0013; AD-647463) CFSTI: HC $3.00/MF $0.65

Simultaneous observations of the lower atmosphere with lidar (laser radar) and microwave radar are summarized. The observations are restricted in space to the location of Stanford Research Institute, Menlo Park, California, and in time to June, August, and September 1966. Lidar echoes from the clear lower atmosphere are compared with the temperature and humidity data from the rawinsonde ascents made at Oakland, California. During clear skies, no radar or lidar echoes were observed above 20.00 m. Below this level the atmospheric structure that was analyzed from the lidar data showed a diurnal variation similar to that of the thermal stability of the atmosphere. Other time-dependent variations that were evident in the data are believed to be related to short period changes in the height of the top of the marine layer. No specific relationship was found between the lidar data and the rawinsonde data from Oakland. Radar echoes observed in the clear lower atmosphere were classified as meteorological angles. Author (TAB)

N67-24794# Delaware Univ., Newark. Electrical Engineering Dept.

ON THE QUANTUM STATISTICS OF MODE MIXING

L. F. Jelsma Aug. 1966 28 p refs

(Grant AF-AFOSR-2-65)

(Q61; AFOSR-67-0425; AD-647411) CFSTI: HC $3.00/MF $0.65

This is a semiclassical quantum formulation of mode mixing in nonlinear media employing Glaubers P-representation of the statistical density operator. Coupled mode equations are derived from Maxwell's equations and Hamiltonians are found which generate the coupled mode equations through Hamilton's equations of motion. The state of the system is determined by postulating that a maximum entropy state will be approached if all controlled sources are turned off. An expression representing the statistics of frequency conversion is derived and the noise in an up converter employing a quantum counter is determined. Author (TAB)

N67-24831# RCA Victor Co., Ltd., Montreal (Quebec).

NOISE CONSIDERATION FOR THE DETECTION OF WEAK LASER SIGNALS

A. L. Waksberg and I. P. Shkarofsky Wright-Patterson AFB, Ohio, Aerospace Res. Labs., Sep. 1966 60 p refs

(Contract AF 33(615)-2196)

(Rept.-7-801-49; ARL-66-0181; AD-646744) CFSTI: HC $3.00/MF $0.65

A study is made of the minimum laser signal that can be detected when it is embedded in a background of black body radiation and other sources of noise. In particular, the laser source is assumed to be modulated and a phase lock or pulse coincidence amplifier to be employed. General expressions are derived for the signal-to-noise ratio at the output of a phase lock (or pulse amplifier) for a signal immersed in noise. The types of modulation that are examined comprise sinusoidal, square wave and pulse modulation. The noise considered is that arising from black body and Bremsstrahlung radiation, thermal noise, generation, recombination noise etc.. In particular, laser noise is discussed in some detail. Finally, a Thomson scattering experiment is considered as a special case. Author (TAB)

N67-24904# Hughes Research Labs., Malibu, Calif.

SELECTIVE ACCESS LASER DISPLAY BEAM POSITIONER Quarterly Report, 1 Jun.–31 Aug. 1966

J. F. Lotspeich, W. P. Brown, Jr., and J. E. Kiefer Griffiss AFB, N. Y., RADC, Jan. 1967 72 p refs

(Contract AF 30(602)-4097)

(RADC-TR-66-617; QR-2; AD-646619) CFSTI: HC $3.00/MF $0.65

The investigation concerns the development of a selective access laser display beam positioner capable of presenting a flexible format and multicolor images on large screen map backgrounds. Basic requirements of the beam positioner are microsecond response and random deflection to any of approximately 1,000,000 resolvable spots. The results of a continuing experimental and theoretical effort toward achieving these objectives are presented. The approach is concentrated on studying the performance characteristics of an iterated electro-optic prism beam angle deflector and on establishing the limits of its resolution capability. It is believed that this type of deflector, augmented by one or two stages of binary-switched lateral beam positioner, will provide maximum optical transmission with minimum driving power. Author (TAB)

N67-25008*# National Aeronautics and Space Administration, Washington, D. C.

THE TWO-PHOTON LASER [O DVUKHFOTONNOM LAZERE]

T. M. Il'inova Feb. 1967 11 p refs Transl. into ENGLISH from Vestn. Mosk. Univ., Ser. Fiz. Astron. (Moscow), v. 21, no. 5, 1966 p 39–47

(NASA-TT-F-10621) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The stationary regime of a two-photon laser and its stability are studied. Resonance curves for the excitation of stationary

oscillations are compiled. The non-stationary processes in this system are investigated in the approximation of the given field. When the excitation conditions are fulfilled, the laser emits an impulse having the frequency ω_1 (frequency of the operating transition $\omega_{21}=\omega_2$, where ω_2 is the field frequency $E_2>E_2^{thresh}$ from an outer source). The impulse strength and its duration depend essentially on the magnitude of the field E_2. If $E_2/E_2^{thresh}\geq 1$, then the emitted impulse has a symmetrical form and its energy and duration are determined by the field E_2. In the case of $E_2/E_2^{thresh}>>1$, the signal energy depends only on the properties of the active medium. The duration of the leading edge is determined by the magnitude of the field E_2; the duration of the trailing edge equals the damping time of the resonator at the frequency ω_1. Author

N67-25063*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMMUNICATIONS RESEARCH AND DEVELOPMENT
In its Space Programs Sum. No. 37-44, Vol. III 31 Mar. 1967 p 63–105 refs (See N67-25061 12-07)

Summaries of research on calibration techniques, antenna systems, frequency generation and control, and low noise receivers for the deep space network are presented. A step-recovery diode x6 frequency multiplier for the frequency synthesizer section, Side III of the Mariner Venus 67 precision ranging system is described. The design of a traveling wave maser for operation in the microwave frequency range is reported. Improved calibration techniques are discussed for X-band noise temperature; daily system RF noise temperature, and S-band rotary vane attenuator. Details are given on X-band gain measurements and gain measurements using Surveyor I signals for the advanced efficient antenna systems. N.E.N.

N67-25064*# Jet Propulsion Lab., Calif. Inst. of Tech., Calif.
COMMUNICATIONS DEVELOPMENT ENGINEERING
In its Space Programs Sum. No. 37-44, Vol. III 31 Mar. 1967 p 107–111 (See N67-25061 12-07)

In support of the deep space network, a study was made of the Az–El antenna structure deformations from gravity loads, and contour maps of deformations are presented. Structural changes mentioned are the removal of the counterweight and the ties between the reflector structure, and the addition of a few reinforcing bars. It is also stated that improvement in the reliability of the atomic hydrogen maser is anticipated by replacing all vacuum tubes with solid state devices. N.E.N.

N67-25122# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SOLID STATE DEVICE RESEARCH
In its Solid State Res. 30 Jan. 1967 p 1–14 refs (See N67-25121 13-26)

Reports are presented on continuing development of solid state devices and research on their cryogenic characteristics. Photovoltaic responses in p–n junctions of $Pb_{1-x}Sn_xTe$ indicate that alloys in this series have potential for infrared detection throughout the 8 to 14μ atmospheric window. Infrared emission was observed from diode lasers of $Pb_{1-y}Sn_ySe$ and $Pb_{1-x}Sn_xTe$. Single crystal graded-gap heterojunctions were produced between GaAs and InSb, using the interface alloy technique. Phosphorus ions were implanted in germanium with a 400 keV Van de Graaff positive ion accelerator, producing n-type regions in bulk p-type material. Good quantitative agreement is reported between measured small-signal admittance parameters of GaAs negative conductance amplifiers and those calculated from the three-slope piecewise-linear model for velocity vs electric field. Efficiencies as high as 9% were obtained for Gunn effect oscillators with very pure epitaxial layers of GaAs grown on Cr-doped semi-insulating GaAs substrates. N.E.N.

N67-25123# Lincoln Lab., Mass. Inst. of Tech., Lexington.
OPTICAL TECHNIQUES AND DEVICES
In its Solid State Res. 30 Jan. 1967 p 15–19 refs (See N67-25121 13-26)

Heterodyne sensitivity at 10.6μ was measured using a Cu-doped germanium photoconductor at liquid helium temperature. The measured minimum detectable power is within 10 dB of the theoretical limit, 2×10^{-20} W/Hz bandwidth. The signal frequency was 60 kHz and the noise bandwidth approximately 300 kHz. A sealed-off CO_2 laser was operated for approximately 100 hours without serious loss in output power. Although the gas fill was CO_2, N_2, and He, spectra of the visible spontaneous emission from the side of the tube indicate the presence of CO, CN, and N_2. Author

N67-25125# Lincoln Lab., Mass. Inst. of Tech., Lexington.
PHYSICS OF SOLIDS
In its Solid State Res. 30 Jan. 1967 p 39–61 refs (See N67-25121 13-26)

Continuing studies on the physical properties of solids are briefly reported. The areas of investigation are: electronic band structure of semiconductor materials, magnetism and Heisenberg models, transport theory, and laser scattering experiments. N.E.N.

N67-25431# Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.
ELECTRONIC FRINGE SIGNAL DETECTION CIRCUITRY FOR LENGTH-MEASURING INTERFEROMETERS
J. J. Henry and W. A. Groppe 9 Feb. 1967 31 p refs
(Contract W-7405-ENG-26)
(Y-1566) CFSTI: HC $3.00/MF $0.65

An electronic signal-conditioning system has been designed for use with laser-actuated length-measuring interferometers. Many improvements have been incorporated in this design to provide extended frequency response, stability, and operator convenience. These improvements allow shop use of the interferometer by nontechnical personnel for inspection and machine-tool control. Test results obtained from four prototype systems demonstrate the capability of the design. Maintenance and operating procedures are included for both the electronic and optical systems. Author

N67-25449# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE QUANTUM GENERATOR IN SPACE
7 Dec. 1966 7 p Transl. into ENGLISH from Pravda (Moscow), 1 Nov. 1966 p 4
(FTD-HT-66-725; AD-647730) CFSTI: HC $3.00/MF $0.65

The Cosmos 97 satellite contained an ammonia-molecule laser as a frequency generator for application in determining the satellites trajectory. The laser operates on solar batteries, is set up on the external surface of the satellite, covered with a sheathing and connected with apparatus inside the satellite through hermetic leads. Its operation is controlled through a special command radio link from groundpoints and autonomically, through a program time device. Author (TAB)

N67-25566 Atomic Energy Centre, Lahore (Pakistan).
LASERS—A BIBLIOGRAPHY
M. M. Rafique Mar. 1966 92 p refs
(AECL-PAK/LIB-12)

A bibliography is presented which contains 1152 references to literature on the technology, uses, and applications of lasers. R.N.A.

N67-25669*# Sylvania Electric Products, Inc., Mountain View, Calif. Western Operation.
FREQUENCY-STABILIZED CO_2 LASERS, PHASE I
R. S. Reynolds, A. E. Siegman, J. D. Foster, and R. Rogers 12 Aug. 1966 135 p refs
(Contract NAS8-20631)
(NASA-CR-83821; SESW-G534) CFSTI: HC $3.00/MF $0.65 CSCL 20E

A study effort to establish the best techniques for attaining a $1:10^{10}$ frequency-stabilized CO_2 laser is reported. The report discusses several electronic and mechanical stabilization schemes, control loop techniques, wavelength and mode control techniques, and general laser construction and operation approaches. It appears that a technique which stabilizes the CO_2 laser frequency to an external CO_2 amplifier is capable of providing the required frequency stability. Author

N67-25807* International Information, Inc., Philadelphia, Pa.
THEORY OF A TWO-PHOTON LASER [K TEORII DVUKHFOTONNOGO LAZERA]
T. M. Il'inova Feb. 1967 13 p refs Transl. into ENGLISH from Vestn. Mosk. Univ. (Moscow), no. 4, 1966 p 79-87
(Contract NASw-1499)
(NASA-TT-F-10629) CSCL 20E

Equations are derived which describe nonstationary processes in a two-photon laser. Conditions of self-excitation of such a system are derived in the approximation of the given field. It is shown that at the metastable second working level a field E_1 of difference frequency ω_1 can be excited even in the absence of an initial inverse difference of populations if the field E_2 from an external coherent source is greater than some threshold value. The steady state and its stability are investigated. Author

N67-25823*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
SENSING OF METEOROLOGICAL VARIABLES BY LASER PROBE TECHNIQUES Semiannual Report, 1 Aug. 1966-31 Jan. 1967
Giorgio Fiocco 10 Mar. 1967 12 p refs
(Grant NGR-22-009-131)
(NASA-CR-83869) CFSTI: HC $3.00/MF $0.65 CSCL 04B

Observed profiles of optical radar scattering cross sections in the atmosphere as a function of altitude were analyzed to provide information on atmospheric dust content from 10 to 150 km. A significant negative correlation between fluctuations of dust and ozone was observed. An acceleration model for upper atmospheric molecules using incoming micrometeorites and successive neutral-neutral ionizing collisions established 4×10^3 tons/day for the influx rate of cosmic dust as sufficient to produce the observed ionization amounts in the E-region at night. Fluctuations in stratospheric dust amounts could not be correlated to precipitation. Also reported was the construction of a photoelectric Fabry-Perot interferometer that can be pressure-scanned for air temperature measurements at specific atmospheric pressure. G.G.

N67-25975# Ballistic Research Labs., Aberdeen Proving Ground, Md.
EFFECTS OF POWER DENSITY ON CHARACTERISTICS OF LASER BEAM INTERACTION WITH SOLID MATERIALS
William F. Braerman and Charles R. Stumpfel Sep. 1966 47 p refs
(BRL-MR-1791; AD-646732) CFSTI: HC $3.00/MF $0.65

The power density of a 2.8 msec pulse length laser was varied from approximately 100,000 to 10,000,000 watts per square centimeter in order to observe various laser beam solid interaction characteristics. Mass loss, penetration depth, and time integrated and some time-resolved spectroscopic results are reported for tungsten, pyrolytic graphite, aluminum and copper. Author (TAB)

N67-26068*# Perkin-Elmer Corp., Norwalk, Conn. Optical Group.
QUIET LASER PROGRAM Final Report
Paul H. Lee and Michael T. Skolnick 16 Mar. 1967 94 p refs
(Contract NAS8-11979)
(NASA-CR-83961; Rept.-8639) CFSTI: HC $3.00/MF $0.65 CSCL 20E

A study was made of methods for achieving outstanding short-term frequency stability in gas lasers. The factors affecting this stability of open-loop lasers were investigated, and resulted in the design of open-loop single mode diffraction limited lasers. Two of these lasers were then slaved to the resonant frequencies of two independent passive reference cavities, and the resulting drift rate was substantially better than that of the open-loop lasers alone. The lasers had a linewidth of approximately 15 kHz under average room noise conditions, and the drift rate when thermally stabilized was approximately 3 MHz per hour. C.T.C.

N67-26255# Electro-Optical Systems, Inc., Pasadena, Calif.
SURFACE EVALUATION AND DEFINITION (SUEDE) PROGRAM
R. L. Kirk 13 Dec. 1966 111 p refs
(Contract NOw-66-0509-c)
(EOS-7067-Final; AD-646828) CFSTI: HC $3.00/MF $0.65

The first phase of the SUEDE program was to determine the feasibility of utilizing airborne laser techniques to measure sea state parameters and the velocity and direction of wind adjacent to an ocean surface. A summary of facts presently established is as follows: (a) The wind parameters adjacent to a water surface can be inferred remotely through the use of laser electro-optical instrumentation. (b) Wave height can be measured utilizing an AM/cw laser instrumentation concept and suitable data processing techniques. (c) The optimum laser transmission frequency based upon atmospheric transmission parameters as well as operational equipment considerations is 1.06 microns. (d) The SUEDE instrumentation can be constructed now utilizing available state-of-the-art technology and components. (e) Fine grain data on the reflective properties of ocean surfaces subjected to various wind fields is not available. The prototype SUEDE instrumentation would offer the fastest and most inexpensive means of obtaining this data. Accuracy evaluation of projected operational equipment requires this data. (f) Density variations beneath the ocean surface will not produce reflective returns that would modify expected system performance. Author (TAB)

N67-26331* California Univ., Berkeley. Space Sciences Lab.
LASER SURFACE INTERACTIONS: CREATION AND DETECTION OF ATOMICALLY CLEAN SURFACES Semiannual Report, Oct. 1, 1966-Mar. 31, 1967
Harold P. Smith, Jr. 31 Mar. 1967 5 p *Its* Space Sci. Lab. Ser. No. 8, Issue No. 20
(Grant NGR-05-003-161)
(NASA-CR-84054) CFSTI: HC $3.00 CSCL 20E

Methods of identifying a clean surface are discussed, with attention centered on the use of low energy electron diffraction (LEED) by which the diffraction of low energy electrons can identify an atomically-ordered surface. In the experimental arrangement, an aluminum target was aligned perpendicular to the axis of the laser and then pulsed by the Q-switched laser. After laser bombardment, the target was annealed and rotated back into alignment with the electron gun, and the diffraction pattern was observed. It was concluded that the capability of the laser to disorder the surface by heating and evaporation was established, and the energy and power densities necessary to achieve this were determined. M.G.J.

N67-26352# California Univ., Livermore. Lawrence Radiation Lab.
CALIBRATION TECHNIQUES FOR LASER BEAM MONITORS

Donald T. Davis 16 Dec. 1966 15 p refs
(Contract W-7405-ENG-48)
(UCRL-50165) CFSTI: HC $3.00/MF $0.65

Procedures are presented for calibrating pulsed-laser beam monitors (sampling type) in terms of energy and power per volt using an absorption-type calorimeter as the standard. Techniques are described for minimizing absolute and random errors in data acquisition. A comprehensive error analysis shows how the absolute and relative accuracies of the device depend on calibrating over a finite number of observations. Author (NSA)

N67-26398 Lockheed Missiles and Space Co., Palo Alto, Calif.
EXPERIMENTAL INVESTIGATION OF THE DISPERSION OF INSTANTANEOUSLY HEATED MATERIAL AND OF THE ORIGINATING IMPULSE AT ENERGY CONCENTRATIONS LESS THAN THE HEAT OF EVAPORATION
A. A. Kalmykov, I. V. Nemchinov, and A. I. Petrukhin [1966] 14 p refs Transl. into ENGLISH from Prikl. Mekhan. i Tekhn. Fiz. (USSR), no. 6, 1966 p 3–13

The splitting off of the surface layer of material during rapid heating to energy concentrations per unit mass less than the heat of evaporation was verified experimentally under the effect of radiation from a laser operating in the modulated quality mode. The picture of material dispersion was investigated by high-speed photography. The values of the impulse I were measured for various energy concentrations, and it is shown that the dependence of I on the value of the energy E supplied agrees with theoretical estimates. It is shown that determination of the pressure pulse generated in the dispersion of the instantaneously heated and then splitting material affords the possibility of investigating its thermodynamic properties at an almost normal density. Author

N67-26399 Lockheed Missiles and Space Co., Palo Alto, Calif.
EFFECT OF A LASER LIGHT BEAM ON ORGANIC GLASS
A. I. Akimov, L. I. Mirkin, and N. F. Pilipetskii [1966] 6 p refs Transl. into ENGLISH from Prikl. Mekhan. i Tekhn. Fix. (USSR), no. 6, 1966 p 14–18

Previous results on the effect of laser light radiation on transparent materials are reported, and, based on these results, an investigation was made of the subjection of Plexiglas to powerful laser radiation. A quality-modulated laser with regulated output power was utilized. The glow of the focused radiation within the transparent sample at the time of the light pulse was recorded by photographic apparatus. The picture of the fracture was then investigated by a microphotographic method. Two sharply differing kinds of fracture were distinguished: fracture with the formation of a set of microcracks and fracture with the formation of significant flat cracks. The transition from one kind of fracture to the other was observed by changing the focal length of the lens and the pulse duration from 10^{-3} to 10^{-8} sec. L.E.W.

N67-26452*# Illinois Univ., Urbana. Gaseous Electronics Lab.
EXPERIMENTAL INVESTIGATION OF THE INTERACTION BETWEEN THE ELECTRON GAS AND THE EXCITED ATOMS IN A PLASMA BY MEANS OF A XENON LASER
R. Freiberg and L. Goldstein Nov. 1966 135 p refs
(Grant NGR-14-005-037)
(NASA-CR-84115, SR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The interaction between the electron gas and the atoms in excited states was studied for a gas discharge situated in a high gain optical cavity. Of particular interest is the effect of lasering upon this interaction. Spatially resolved electron density and electron temperature measurements are presented for a dc excited 3.51 μ ($5d_{33} \rightarrow 6p_{22}$) xenon laser operating in a capillary bore tube over a pressure range of 12.5 to 25.5 m torr. Anode directed gradients in the electron and neutral gas densities are observed and are attributed to electrophoretic effects present in the closed capillary discharge tube. As a result of these gradients, the local population inversion along the axis of the tube varies and, consequently, affects the output of the 3.51 μ laser. The influence of lasering upon these low-pressure capillary xenon discharges is investigated experimentally by periodically spoiling the Q of the laser cavity by means of a mechanical chopping wheel. It is observed that lasering noticeably alters both the state of the electron gas and the populations of the excited xenon atoms. Author

N67-26537*# Massachusetts Inst. of Tech., Cambridge. Experimental Astronomy Lab.
LONG-TERM LASER FREQUENCY STABILIZATION USING A MOLECULAR BEAM
S. Ezekiel *In its* Rev. of NASA Sponsored Res. at the Exptl. Astronomy Lab. Jan. 1967 p 105–108 (See N67-26521 14-21)

Brief technical details are presented on the present status of frequency stabilization techniques, and the proposed approach to laser stabilization by using a molecular beam. The method of utilizing the atomic, or molecular, beam as the frequency reference for the long term stabilization of a laser is described, and a pertinent schematic is included. R.LI.

N67-26618*# Columbia Univ., New York. Columbia Radiation Lab.
PHYSICS OF MOLECULES
In its Res. Invest. Directed Toward Extending the Useful Range of the Electromagnetic Spectrum 31 Oct. 1966 p 50–75 refs (See N67-26616 14-24)
(Contracts N00014-67-A-0108-0002; DA-31-124-ARO(D)-296; Grant AF-AFOSR-330-66)

Molecular physics research efforts are reported under the following subheadings: beam maser spectroscopy, electron excitation of molecular hydrogen, scattering of velocity selected molecular beams, magnetic rotation spectra, molecular spectra of cesium, laser studies of molecular birefringence and optical activity, and optical laser spectroscopy of fluids. R.LI.

N67-26707# Pennsylvania State Univ., University Park. Dept. of Physics.
STIMULATED EFFECTS IN N_2 AND CH_4 GASES
T. A. Wiggins, R. V. Wick, and D. H. Rank *In its* [Res. Proj. of the Dept. of Phys.] 31 Dec. 1966 17 p refs Supported by ONR (See N67-26703 14-16)

Stimulated Brillouin scattering from N_2 and CH_4 using a giant pulse laser has been observed in an arrangement whereby the laser cannot re-lase and amplify the backscattered radiation. This allows a quantitative study of the parameters affecting stimulated Brillouin scattering. The backscattered beam converges at the same angle at which the laser beam diverges. The Brillouin component can have a narrow spectral width, 1/3 that of the laser itself, and in some cases can have a duration of only a few nanoseconds. N_2 at high pressure can backscatter as much as 45% of the incident power. The speeds of sound in CH_4 and N_2 have been measured at lower pressures than were previously reported. Author

N67-26708# Pennsylvania State Univ., University Park. Dept. of Physics.
PERFORMANCE OF A VIBRATION H_2-STOKES OSCILLATOR
P. V. Avizonis, A. H. Guenther (AF Weapons Lab.), T. A. Wiggins, R. V. Wick, and D. H. Rank *In its* [Res. Proj. of the Dept. of Phys.] 31 Dec. 1966 10 p refs Supported by ARPA (See N67-26703 14-16)

A H_2-Stokes Raman Oscillator was constructed operating at 9755 Å. and its performance was found to be as expected of laser oscillators. No beam instability was developed (beam trapping), confirming earlier measurements. A significant beam brightness enhancement (in terms of linewidth and beam divergence) over that of the Q-switched ruby laser resulted. Author

N67-26709# Pennsylvania State Univ., University Park. Dept. of Physics.
STIMULATED OPTICAL FREQUENCY MIXING IN LIQUIDS AND SOLIDS
R. V. Wick, D. H. Rank, and T. A. Wiggins *In its* [Res. Proj. of the Dept. of Phys.] 31 Dec. 1966 6 p refs Supported by ONR (See N67-26703 14-16)

Described are experimental observations of ruby laser stimulated optical frequency mixing in two liquids (carbon disulfide and aniline) and two optical glasses. Remarks concerning previous observations of the stimulated Brillouin effect in liquids and solids are included to clarify experimental findings. S.C.W.

N67-26710# Pennsylvania State Univ. University Park. Dept. of Physics.
OPTICAL MIXING IN STIMULATED BRILLOUIN SPECTRA
T. A. Wiggins, R. V. Wick, N. D. Foltz, C. W. Cho, and D. H. Rank *In its* [Res. Proj. of the Dept. of Phys.] 31 Dec. 1966 16 p Supported by ONR and NSF (See N67-26703 14-16)

Optical mixing in twenty-three liquids and two glasses is reported. Observations with a high-resolution grating spectrograph of the light from a giant-pulse ruby laser transmitted through the materials reveal the presence of more Stokes-shifted components than can be accounted for on the basis of amplification by the laser of Brillouin shifted frequencies. In addition, anti-Stokes shifted components are observed. The frequency shifts are shown to correspond to those expected for 180° Brillouin scattering. Sound speeds calculated agree in general with those from stimulated and spontaneous scattering experiments. Sound-speed measurements at different temperatures and for two-component liquids give results predictable from bulk properties of the liquids. A number of experiments showing the conditions and the parameters which affect the optical mixing are described. Author

N67-26711# Pennsylvania State Univ., University Park. Dept. of Physics.
STIMULATED RAYLEIGH SCATTERING
C. W. Cho, N. D. Foltz, D. H. Rank, and T. A. Wiggins *In its* [Res. Proj. of the Dept. of Phys.] 31 Dec. 1966 9 p refs Supported by ONR and NSF (See N67-26703 14-16)

Reported are results of spectrographic observations of ruby laser stimulated Rayleigh scattering from liquids. S.C.W.

N67-26752# Brandeis Univ., Waltham, Mass. Dept. of Physics.
THEORY OF AN OPTICAL MASER IN A MAGNETIC FIELD
Peter Hammerling Oct. 1966 13 p refs
(Contract AF 19(628)-5833)
(SR-2; AFCRL-66-813; AD-648238) CFSTI: HC $3.00/MF $0.65

The theory of an optical maser in the presence of an external static magnetic field has been discussed recently by several authors. It is now shown that a considerable simplification of the theory results when one uses a tensor operator expansion of the density matrix describing the system. Author (TAB)

N67-26758# Raytheon Co., Waltham, Mass. Research Div.
MODE-LOCKING AND MODE PROPERTIES OF OPTICAL LASERS Final Scientific Report, Jan.–Dec. 1966
H. Statz and G. A. de Mars Mar. 1967 63 p refs
(Contract AF 19(628)-5819)
(S-928; AFCRL-67-0084; AD-648262) CFSTI: HC $3.00/MF $0.65

The report contains: Self-Locking in Modes in Lasers and phase-locking effects between longitudinal modes in lasers. The expected phases of oscillating modes depend in a complicated manner upon the relaxation times T1 and T2 of the medium, on the degree of inhomogeneous broadening, the mode separation and location of the medium in the cavity. Simple formation of sharp output spikes at the fundamental frequency are expected where crystals like ruby or YAG are placed near the edges of the cavity. Sharp spikes at twice the fundamental frequency are expected when these solids are placed in the center of a cavity. Investigations have been completed on the mode-locking in ruby lasers where the crystals are located near the mirrors or in the center of the cavity. The observed results are in agreement with the theory. Phase-Locking of Laser Oscillators by Injected Signal and the Minimum Frequency Separation in Rotation Sensing Ring Lasers. The condition for frequency-locking of a laser oscillator by an externally injected signal is derived. The results are valid for both homogeneously and inhomogeneously broadened lines. Effects of Intensity-Dependent Anomalous Dispersion on the Mode Shapes of Fabry-Perot Oscillators. Previous work in this laboratory, as well as work by Fox and Li, has shown that the mode shapes in Fabry-Perot resonators do not change much due to the intensity-dependent saturation of the laser medium. The only effect sometimes expected with curved mirrors is that the lowest threshold oscillating mode is not the Te00 mode but one exhibiting radial nodes. However, the calculations assume that the laser oscillation is one line center. Author (TAB)

N67-26953# California Univ., La Jolla. Visibility Lab.
UNDERWATER OPTICS
S. Q. Duntley 10 Dec. 1966 20 p
(Contract Nonr-2216(14))
(AD-647791) CFSTI: HC $3.00/MF $0.65

The irradiance pattern was measured for the propagation of a collimated beam of light underwater. A neodymium-doubled green laser was transmitted horizontally at a six foot depth in Lake Winnipesaukee, N. H. The irradiance was measured at distances from 0 to 100 feet and for off-axis angles from 0 to 58 degrees. The water had an attenuation length of 4.54 ft/ln and an absorption coefficient of 0.0446 ln/ft. The ratio of attenuation coefficient to absorption coefficient was 4.94. The fractional power contained within a cone of various angles was computed. At 20 attenuation lengths only 10% of the total power is contained within a cone of 4 degrees whereas at 4 attenuation lengths this same cone contains 50% of the power. Author (TAB)

N67-26977# System Development Corp., Santa Monica, Calif.
LARGE CAPACITY LASER MEMORY FOR SPACEBORNE COMPUTERS
I. Dlugatch and S. Manus 13 Feb. 1967 11 p Presented at the 1st Ann. Princeton Conf., on Inform. Sci. and Systems, Princeton, N. J., Mar. 1967
(SDC-SP-2665; AD-648752) CFSTI: HC $3.00/MF $0.65

The report discusses the necessity for a spaceborne computer memory of at least 10 to the 7th power bit capacity. It is shown that such a device could minimize computer hardware and, at the same time, make feasible such devices as spaceborne random-multiple-access and synergetic satellites. Author (TAB)

N67-27097*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
INTERACTION OF LASER RADIATION WITH PLASMAS AND NONADIABATIC MOTION OF PARTICLES IN MAGNETIC FIELDS

In its Res. Lab. of Electron. 15 Apr. 1967 p 223-229 refs
(See N67-27081 14-23)
(Contract AT(30-1)-3285)

Summarized technical progress is reported on incoherent scattering of light from a Plasma IV, and electron diffusion in a helically perturbed magnetic field of stellarator. The interaction of laser radiation with plasmas and nonadiabatic motion of particles in magnetic fields is stressed. R.LI.

N67-27125 Weapons Research Establishment, Salisbury (Australia). Dept. of Supply.
THE POTENTIALS OF PRESENT DAY LASERS AS SCIENTIFIC PROBES FOR INVESTIGATING THE STRUCTURE OF MATTER
J. L. Hughes Jan. 1967 16 p refs
(WRE-TN-PAD-126)

A survey of the techniques required to produce photon energy densities in the range 10^{17} to 10^{25} ergs per cm^3 is given. It is concluded that light amplification using rods cannot achieve these powers and the concept of the exponential amplifier is proposed together with the results of some initial optical tests. It is concluded that the most likely present day contender is neodymium doped glass although the costs involved would be comparable to those of the most powerful of particle accelerators built to date. The major part of this cost would go into the development of photo emitting diodes with a 100Å band at 8800Å capable of several kilowatts pulsed power over a one cm^2 aperture in about 300μs. Author

N67-27128# Weapons Research Establishment, Salisbury (Australia). Dept. of Supply.
LASER MODULATION USING LINEAR ELECTRO-OPTIC CRYSTALS
J. R. Pyle Dec. 1966 40 p refs
(WRE-TN-PAD-125) CFSTI: HC $3.00/MF $0.65

The theory of laser modulation using the linear electro-optic effect exhibited by certain crystals is described. Basic modulator configurations have been investigated theoretically and experimentally and good agreement has been found. The use of multiple crystal modulators is advocated for increased modulation sensitivity to driving voltage. Television transmission over a Helium-Neon laser beam is described. Author

N67-27162# Michigan Univ., Ann Arbor. Cooley Electronics Lab.
THE STUDY OF NEW CONCEPTS IN SOLID STATE TRANSDUCERS Final Report, 9 Sep. 1965-31 Aug. 1966
Ralph M. Grant Feb. 1967 63 p refs
(Contract Nonr-1224(60))
(Rept.-7590-F; AD-647957) CFSTI: HC $3.00/MF $0.65

Holographic techniques were shown to be very informative about the steady-state vibrational behavior of transducers. Holograms of objects vibrating underwater were successful; but, more developmental work is needed before high quality results can be obtained. Real time fringes were shown to be very useful in the laboratory for finding transducer resonances (the time average hologram then gives detailed results). They hold promise for studying transient effects. Another promising application of our holographic studies follows directly from the Directionally Sensitive Membrane Employing Optical Diffraction. This would be a stretched membrane or a very thin clamped plate for which real time fringes are produced. Any sound wave striking the plate would disturb the real time fringes. Very minute pressure disturbances could be detected. Author (TAB)

N67-27179# Illinois Univ., Urbana. Electro-Physics Lab.
GAS LASER STUDIES IN THE 100 TO 1000 MICRON RANGE—A REVIEW OF ACTIVITIES Final Report, 1 Jan.-30 Sep. 1966
Paul D. Coleman Dec. 1966 31 p refs
(Grant AF-AFOSR-804-66)
(AFOSR-67-0689; AD-648760) CFSTI: HC $3.00/MF $0.65

The report summarizes nine months of the second year activity of research on molecular lasers in the 100 to 1000 micron range. Progress on identifying the lasing specie and making energy level assignments for a water vapor laser are described. Also included is a summary of optimum output coupling of lasers by means of apertures and semi-transparent mirrors. This study was carried out at 337 microns wavelength. Author (TAB)

N67-27445# United Aircraft Corp., East Hartford, Conn. Research Labs.
PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES Semiannual Report, 29 Jun.-31 Dec. 1966
Alan F. Haught and Donald H. Polk 31 Jan. 1967 31 p
(Contract AT(30-1)-2578)
(NYO-3578-5; UARL-E-920365-5) CFSTI: HC $3.00/MF $0.65

An experimental and theoretical investigation was made of the production of plasmas for thermonuclear research by laser beam irradiation of a small solid particle. For these studies the focused high intensity beam from a Q-spoiled laser is used to form a high-temperature, high-density plasma from a single solid particle of lithium hydride 10 to 20 μ in diameter which is electrically suspended in a vacuum environment free of all material supports. Both detailed hydrodynamic calculations and a simplified integrated similarity model of the plasma generation and growth have been developed. These models, which include the effects of laser pulse time history, fraction of the incident beam absorbed by the expanding plasma, and radial density and velocity gradients within the plasma, give results for the plasma radial density distribution, velocity profile, and plasma energy in good agreement with those determined experimentally. NSA

N67-27499# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
INTENSE PULSED SOURCES OF IONS AND ELECTRONS PRODUCED BY LASERS [SOURCES PULSEES INTENSES D'IONS ET D'ELECTRONS PRODUITS PAR LASER]
Guy Bourrabier, Terenzio Consoli, and Lucien Slama Nov. 1966 21 p In FRENCH
(CEA-R-3109)

A device is described for the acceleration of plasma bursts produced by focusing a laser beam into a metal target. The electrons and ions are extracted from the plasma. The maximum current is around 2000 amperes for a few microseconds. The study of the effect of the kind of target on characteristics of the current shows the great importance of initial conditions, i.e., the ionization potential of the target and the laser energy. Author (NSA)

N67-27669*# Massachusetts Inst. of Tech., Cambridge. Dept. of Physics.
ABSOLUTE FREQUENCY MEASUREMENT OF THE 190μ AND 194μ GAS LASER TRANSITIONS
L. O. Hocker, D. Ramachandra Rao, and A. Javan [1967] 5 p refs
(Grant NsG-330)
(NASA-CR-84506) CFSTI: HC $3.00 CSCL 20E

By harmonic mixing with a 70 GHz source, the frequencies of the 190 and 194μ laser transitions in a D_2O and C_2N_2 discharge have been measured as 1578.279 and 1539.756 GHz. Author

N67-28087# Cornell Univ., Ithaca, N. Y. Materials Science Center.
THREE-PHOTON PHOTOELECTRIC EFFECT IN GOLD

E. M. Logothetis and Paul L. Hartman 22 Feb. 1967 13 p refs
(Contract Nonr-401(47))
(Rept.-648; AD-648167) CFSTI: HC $3.00/MF $0.65

A report is given of the observation and study of a three-photon photoelectric effect in gold at room temperature using a Q-switched ruby laser (photon energy 1.786 eV). Gold has a (photoelectric) work function W = 4.8 eV, much higher than the energy of two laser photons (3.57 eV), but lower than the energy of three laser photons (5.36 eV). TAB

N67-28329# Linde Div., Union Carbide Corp., Indianapolis, Ind.
CZOCHRALSKI RUBY Annual Technical Summary Report, Jan 1–Dec. 31, 1966
George A. Keig, O. H. Nestor, Peter E. Otten, and J. C. Smith
20 Mar. 1967 53 p refs
(Contract Nonr-4132(00); ARPA Order 306-62)
(SRCR-67-5; AD-649282) CFSTI: HC $3.00/MF $0.65

The Czochralski growth technique was developed to yield large ruby crystals with optical quality suitable for use as solid state lasers. This involved a scale-up of the present growth process to produce crystals 2 inches in diameter and 12 inches long. The material properties of the ruby have been studied with special attention given to its behavior during active lasing. The properties receiving attention have been chromium distribution and the identification and removal of inclusions causing laser damage during Q-switched operation. Author (TAB)

N67-28362# Royal Aircraft Establishment, Farnborough (England).
ADJUSTABLE MIRROR MOUNT DESIGN USING KINEMATIC PRINCIPLES
D. A. Bateman Nov. 1966 29 p refs
(RAE-TR-66349) CFSTI: HC $3.00/MF $0.65

Various designs of mirror mounts are discussed in relation to their performance, construction, and choice of materials together with the principles of kinematic design. Examples are given of systems incorporating many of the optimum design features described which have a precision of several seconds of arc and which are suitable for general optical and laser work. Author (ESRO)

N67-28556# Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.
LASER DAMAGE: A SELECTED LITERATURE SURVEY
Carl A. Pitha Feb. 1967 19 p refs *Its* Spec. Rept. No. 60
(AFCRL-67-0137; AD-651210) CFSTI: HC $3.00/MF $0.65

This report is a review of selected references dealing with descriptions and possible causes of damage to laser component elements functioning under high-power conditions, or to potential laser component materials exposed to high-power laser beams. Discussed are internal and surface damage, conditions prevailing in materials under lasing conditions, and the mechanisms proposed to account for the accumulation of sufficient energy for damage to take place; that is, self-focusing, stimulated Brillouin scattering, multiphoton absorption, and microplasma generation. Fifty-seven papers, published in 1964 - 1966, are included in the references. Author (TAB)

N67-28564# Ballistic Research Labs., Aberdeen Proving Ground, Md.
IGNITION OF SOLID COMBUSTIBLES BY A RUBY LASER
Joseph L. Robitaille Oct. 1966 29 p refs
(BRL-MR-1799; AD-649526) CFSTI: HC $3.00/MF $0.65

The ignition of solid combustibles with a 3 millisecond pulse ruby laser has been performed. The samples investigated are newspaper, alpha cellulose, kraft paper, cotton, clothing, grass and wood. The samples studied were categorized according to their reflectances and absorptances at a wavelength of 6943A. The threshold energy for sustained ignition is reported as joules per unit area delivered to the surface of the material. The results of these experiments show that sustained ignitions depend upon the area exposed to the laser beam, the reflectance of the surface in the case of newspaper samples, and the thickness of the material. Wood shingles and cloth were only damaged; carbon impregnated alpha cellulose thicker than 8 mils and newspaper samples thicker than 19 mils did not burn. Author (TAB)

N67-28692# Naval Ordnance Lab., White Oak, Md.
FEASIBILITY STUDY OF THE DETERMINATION OF SHOCK DETACHMENT DISTANCE AND ABLATION ON LUMINOUS BODIES USING A LASER LIGHT SOURCE
John L. Lankford 1 Feb. 1967 34 p refs
(NOLTR-67-18; Ballistics Res. Rept.-170; AD-650875) CFSTI: HC $3.00/MF $0.65

A laser light source was employed in a shadowgraph system in a 1000-foot hyperballistics range to investigate new techniques for observing the shock shape, detachment distance, and nose shape for luminous and ablating models at hypersonic speeds. Film fogging and distortion, usually present when the aerodynamic heating at high velocities causes ablation and luminosity at the nose of the model, were markedly reduced, using a selective focusing technique and a Q-switched ruby laser light source. Shock detachment distances measured directly from film plates compare well with the results from previous indirect techniques that are not applicable to luminous or ablating bodies. The method described shows promise for application to the study of model recession under simulated re-entry conditions and for investigation of the relation of model shape changes to ablation, shock shape, and shock detachment distance. Author (TAB)

N67-28996# North Carolina State Coll., Raleigh. School of Physical Sciences and Applied Mathematics.
EFFECTS OF GAMMA IRRADIATION ON URANIUM DOPED CALCIUM FLUORIDE, PART II Final Report, 8 Oct. 1965–7 Dec. 1966
Benjamin T. Gravely Dec. 1966 65 p refs
(Contract DA-01-021-AMC-13339(Z))
(AD-650121) CFSTI: HC $3.00/MF $0.65

The effects of Co^{60} and Cs^{137} gamma radiation on the 0.2 microns to 1.1 microns spectral region of $CaF_2:U^{3+}$ were studied. Radiation induced absorption bands formed at 0.320, 0.405, and 0.595 micron appear to be the results of three distinct types of centers. The shape of the band at 0.595 micron indicates that there may be several composite bands in this region. The energy levels of these bands lie between 14,000/cm and 18,000/cm which is just above the quadruplet-I15/2 levels of the imperturbed uranium ions. Decay of the radiation induced center band spectrum due to time and due to optical bleaching with an FX 38A linear flash tube was investigated. The 0.320 micron band decayed less than 15 per cent under flashing, while the 0.405 micron band fell approximately 55 per cent, and the 0.595 micron band fell approximately 45 per cent. The effect of gamma radiation on the laser output of a $CaF_2:U^{3+}$ rod was examined with the help of new low temperature head which could be placed into the sample compartment of the Co^{60} irradiator. An increase of 250 per cent was observed over the unirradiated output. Author (TAB)

N67-29041# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SOLID STATE RESEARCH Quarterly Technical Summary Report, 1 Nov. 1966–31 Jan. 1967
Alan L. Mc Whorter 4 Apr. 1967 69 p refs
(Contract AF 19(628)-5167)
(Rept.-19677:11; ESD-TR-67-162; AD-651065) CFSTI: HC $3.00/MF $0.65

The report covers in detail the solid state research work at Lincoln Laboratory for the period 1 November 1966 through 31 January 1967. The topics covered are Solid State Device Research, Optical Techniques and Devices, Materials Research, and Physics of Solids. Author (TAB)

N67-29046# RCA Victor Co., Ltd., Montreal (Quebec).
DETERMINATION OF THE VELOCITY DISTRIBUTION IN PLASMAS WITH LASERS BY THOMSON AND BY RESONANT SCATTERING Interim Technical Report, 22 Mar. 1965–1 Mar. 1966
Issie P. Shkarofsky Wright-Patterson AFB, Ohio, ARL, Nov. 1966 85 p refs
(Contract AF 33(615)-2196)
(ARL-66-0234; AD-649664) CFSTI: HC $3.00/MF $0.65

Laser scattering methods that appear promising for deducing the single-particle electron-velocity distribution (as well as density and temperature) are described and compared. Single laser Thomson scattering with KL sub D>>1 and a frequency shift greater than the plasma frequency, is reviewed and shown to be feasible for the velocity range between thermal to three times thermal velocity. Also analyzed are methods involving Thomson scattering off the electron plasma or ion plasma resonance with KL sub D<1. A new method is described using the double-laser method of Kroll et al. to scatter off induced plasma oscillations. The detailed theory is presented for arbitrary distribution functions and with fewer assumptions than in other work. Based on Landau damping, this method is suited for the high-velocity range between 2.4 and 4 times thermal velocity, the upper limit given by collisional damping and hence dependent on density. The best density range is between 10 to the 12th power and 10 to the 13th power/cc. With a N2+CO2+He laser at 10.6 microns, the scattering angles are between 10–20 degrees. For an appreciable scattering angle at lower densities, one requires sources between 126 and 1450 times the plasma frequency, when the electron temperature is 3000°K.
Author (TAB)

N67-29117# Texas Instruments, Inc., Dallas. Apparatus Research and Development Lab.
MULTICOLOR LIGHT DISPLAY Final Report
Charles E. Baker and C. M. Alsabrook Feb. 1967 71 p
(Contract AF 30(602)-3910)
(RADC-TR-66-711; AD-650203) CFSTI: HC $3.00/MF $0.65

The report presents the results of a one-year program to develop a Multi-color Laser Display. The purpose of the development was to demonstrate the feasibility of using lasers to produce the primary spectral lines that, when scanned into the standard 525-line television raster, would produce a color presentation compatible with the NTSC encoded video signals. The basic features of the approach used to accomplish the display is presented along with various parameters of the components such as electro-optic light modulator, acoustic scanner, noding mirror scanner, and gas lasers. The results of the evaluation of the display are also presented and analyzed, showing the success of the program. Areas for continued work that would improve performance are also discussed.
Author (TAB)

N67-29129# North Carolina State Coll., Raleigh. Physical Sciences Research.
CHARACTERISTICS OF PULSED LASER CRYSTALS AS A FUNCTION OF GAMMA IRRADIATION Final Report
Grover C. Cobb, William C. Collins, William R. Davis, Benjamin T. Gravely, Marvin K. Moss et al Dec. 1966 50 p refs
(Contract DA-01-021-AMC-13339(Z))
(AD-650120) CFSTI: HC $3.00/MF $0.65

A study of the laser characteristics of CaWO4:Nd(3+), CaMoO4:Nd(3+), LaF3:Nd(3+), LaF3:Pr(3+), CaMoO4:Nd(3+):Tm(3+), Y3Al5O12:Nd(3+), and Y3Al5O12:Nd(3+):Cr(3+) was made as a function of gamma irradiation. In particular, the Co60 gamma radiation produced absoption bands were studied for their effects relating to fluorescent efficiency. CaWO4:Nd(3+) and CaMoO4:Nd(3+) showed very little gamma induced center band structure. The efficiency of CaWO4:Nd(3+) decreased substantially as a function of gamma dose; however, the efficiency of CaMoO4:Nd(3+) was only slightly decreased by a total dose of 2 MR. The doped LaF3 crystals showed a substantial gamma induced center band structure. However, only the LaF3:Pr(3+) exhibited interesting laser characteristics. The efficiency of Y3Al5O12:Nd(3+) was increased significantly by gamma irradiation, first appearing at a dose level of 2,000 R and continuing to a total dose of 15,000 R. At a dose of 20,000 R the overall efficiency had decreased slightly.
Author (TAB)

N67-29346# Ballistic Research Labs., Aberdeen Proving Ground, Md.
A STUDY OF EFFECTS OF LASER IRRADIATION ON HEAD AND EYE OF SMALL ANIMALS IN TERMS OF NEURO-MOTOR BEHAVIOR
William H. Kirby, Jr., John J. Kovaric (Army Dept.) and Larry M. Sturdivan *In* AGARD Loss of Vision from High Intensity Light 1966 p 77–87 refs (See N67-29341 16-04)

Dose, time, and response to focused laser energy to the eyes of mice, rats, and guinea pigs were considered in terms of mortality and effects on neuromotor activity. Results indicate that at the same dosage, blindness occurs if the laser energy is received by the eye and instant lethality results from exposure on top of the head. Very little neuromotor loss resulted from eye shots to white mice at energies as high as 125 joules, although there was complete loss of vision to the injured eye as well as considerable hemorrhage; and for white rats, there appeared to be no loss for energies to approximately 110 joules. For guinea pigs, the higher dosage had to be reached before activity loss resulted. A methodology is suggested for simulating serious eye and neuromotor effects to determine effects on animal performance. M.W.R.

N67-29361# Advisory Group for Aerospace Research and Development, Paris (France).
ORBIT OPTIMIZATION AND LASER APPLICATIONS
Oct. 1964 484 p refs Presented at the Lecture Series on Orbit Optimization and Advanced Guidance Instrumentation, Dusseldorf, 23–24 Oct. 1964
(AGARDograph-92) CFSTI: HC $3.00/MF $0.65

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1. APPLICATION OF OPTIMIZATION TECHNIQUES A. Rosenbloom (Space Tech. Labs.) p 1–21 refs (See N67-29362 16-30)

2. THE APPLICATION OF DYNAMIC PROGRAMMING TO ORBIT TRANSFER PROCESSES F. T. Smith (RAND Corp.) p 23–78 refs (See N67-29363 16-30)

3. STATUS OF LASER TECHNOLOGY R. T. Daly (TRG, Inc.) p 79–108 refs (See N67-29364 16-16)

4. THEORY, METHODS AND APPLICATION OF OPTIMIZATION TECHNIQUES E. L. Peterson (Defense Res. Corp.) p 109–162 refs (See N67-29365 16-19)

5. LASER RECEIVING SYSTEMS B. J. McMurtry (Sylvania Elec. Prod.) p 163–255 refs (See N67-29366 16-16)

6. STATUS OF GUIDANCE AND CONTROL METHODS, INSTRUMENTATION, AND TECHNIQUES AS APPLIED IN THE APOLLO PROJECT W. Haeussermann and R. C. Ducan p 257–484 refs (See N67-29367 16-21)

N67-29364# TRG, Inc., Melville, N. Y. Quantum Electronics Dept.
STATUS OF LASER TECHNOLOGY
Richard T. Daly *In* AGARD Orbit Optimization and Laser Appl Oct. 1964 p 79–108 refs (See N67-29361 16-30)

The laser oscillator is described, and terms used to describe laser operation and performance are included. Laser excitation is mentioned in general terms; and attention is given to the radiance output time dependence; and spectral width of laser oscillations optical pumping; and pumping for molecular dissociation, direct electron excitation, and collisions-of-the-second-kind. Homogeneou

solid or liquid phase lasers, and junction or semiconductor lasers are discussed, along with rangefinding in the atmosphere and in space and precise meteorology. M.W.R.

N67-29366# Sylvania Electric Products, Inc., Mountain View Calif. Optics Dept.

LASER RECEIVING SYSTEMS

B. J. McMurtry *In* AGARD Orbit Optimization and Laser Appl. Oct. 1964 p 163–255 refs (See N67-29361 16-30)

Two types of laser receiving systems are discussed. The first type involves direct detection of amplitude-modulated (AM), phase-modulated (PM), or frequency-modulated (FM) light; and the second type involves heterodyne detection of AM, PM, or FM light. The type of heterodyne receiver used depends upon whether the receiver is part of an optical radar system or an optical communications system. In the radar the laser transmitter also provides the local oscillator (LO) for the receiver, whereas in communications the laser transmitter is usually completely independent of the LO. Two types of radar receivers are described. One uses a fixed frequency LO and a broadband photomixer, and the other uses a tracking LO and a narrow band photomixer. Receiving system components such as detectors, filters, amplifiers, and frequency translators are described, with particular emphasis on detectors and mixers. Two experimental systems are discussed. One involves television communication over a microwave-modulated light beam, and the other is an optical heterodyne receiver using automatic frequency control. Quantum mechanical limitations on the channel capacity of a laser communications system are described. Author

N67-29404# h nu Systems, Inc., Menlo Park, Calif.

LASER PARAMETER MEASUREMENTS HANDBOOK Final Report

H. G. Heard Griffiss AFB, N. Y., RADC, Feb. 1967 296 p refs

(Contract AF 30(602)-3346)

(RADC-TR-66-704, Vol. III; AD-650872) CFSTI: HC $3.00/MF $0.65

The handbook is a compendium of measurement that encompasses the laser technology. It includes a wealth of information gleaned from over 650 articles surveyed in an exhaustive literature search that reviewed American as well as foreign scientific journals, and government reports. This work contains the contributions of 37 authors whose works were edited to conform with the text and abridged to eliminate redundancy. It is believed that the text treats all of the significant laser measurement techniques that have been published to date in the areas of beam sampling, beam parameters, power, energy, gain, wavelength, bandwidth, coherence and frequency stability. The techniques of modulation and the methods of measurement are treated as are the communication aspects of noise in the laser signal source. This volume contains chapters entitled: Measurement of Bandwidth and Coherence; Measurement of Frequency Stability; Measurement of Noise and Modulation of Laser Carriers. TAB

N67-29422# Army Electronics Labs., Fort Monmouth, N. J.

BROADBAND LASER DIGITAL REFLECTOR

S. Leroy Everett, Jr., Robert A. Cicero, David K. Ruppe Jan. 1967 46 p refs

(ECOM-2795; AD-651220) CFSTI: HC $3.00/MF $0.65

The report describes the design of a broadband laser beam digital deflector feasibility model. This model will be a flexible broadband assembly permitting evaluation of numerous broadbanding techniques. Two methods of externally modifying an existing single wavelength digital deflector are described. Both methods provide a beam deflection system operating throughout the 4500A to 7000A portion of the spectrum. Estimates of light intensity losses are calculated for both methods of external modification. Losses are calculated at the discrete laser wavelength to be used in the Laboratory feasibility model. The theory illustrating the method of compensation required for broadband deflector operation is explained. Sample calculations are included for compensation of a two-color model. Laboratory techniques to facilitate compensation of three- and four-color models are included. Problem areas requiring special investigation are outlined. A literary investigation of index of refraction matching fluids is included as an Appendix. The problems encountered with previously used fluids in the deflector and their possible solutions are discussed. Conclusions and recommendations concerning investigation of problem areas and laboratory fabrication of the feasibility model are given. Author (TAB)

N67-29438*# Westinghouse Electric Corp., Baltimore, Md. Surface-Div.

ADVANCED STUDY ON OPTICAL COMMUNICATIONS FROM DEEP SPACE (EXTENSION) Final Technical Documentary Report, 12 Aug. 1966–12 Mar. 1967

12 Mar. 1967 274 p refs

(Contract NAS9-3650)

(NASA-CR-65634) CSCL 20E

Plans for testing optical components of various types of laser communication systems are presented. Materials are selected for testing, and the requirements for both simulated and space flight testing of these materials are presented. A series of communication theory and communication system performance tests are recommended. Details of these tests, required special test equipment, test procedures, and data reduction techniques are explained. Standard test equipment, and ways of implementing these tests are recommended. Predicted results of tests are presented. A computer model to calculate power requirements for deep space optical communications is presented and explained. Sample test results for PPM, PL, and coherent modulation are given. A range tracking system that is compatible with digital television, and has an unambiguous range of 100×10^6 miles is developed. Predictions of its performance during deep space missions are calculated. Author

N67-29445# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.

RESEARCH OF SENSITIZED FLUORESCENCE OF RARE EARTH IONS IN CRYSTALS Progress Report, 16 May–6 Dec. 1966

R. C. Ohlmann, N. T. Melamed, R. Mazelsky, and W. E. Kramer Dec. 1966 67 p

(Contract AF 33(615)-5171)

(Rept.-66-9C1-SXTLS-R1; AD-649831) CFSTI: HC $3.00/MF $0.65

The fluorescence of the rare-earth ions, Eu(3+), Nd(3+), Ho(3+), and Tm(3+) in the host materials Y3Al5O12, Ca5(PO4)3F, YAlO3, GdAlO3 are reported along with the excitation in some cases. These data are used to estimate which ions may be sensitized with transition-metal ions in crystals and will lead to low threshold, high efficiency crystalline lasers. It was found that the rare-earth ions in Ca5(PO4)3F and Y3Al5O12 gave fluorescence lines having more narrow spectral widths than in GdAlO3 and YAlO3. The former two are therefore better materials to choose to sensitize to further improve their laser characteristics. The study of the spectra of manganese, vanadium and titanium in Ca5(PO4)3F indicates that Mn(2+) and (MnO4)(3-) show the most promise as being sensitizers of the rare-earth ions in this host. Initial study of the sensitization of the rare-earth ions has not yet led to any positive results. Attempts to dope Y3Al5O12 with ruthenium were unsuccessful indicating ruthenium is probably not a likely candidate for doping the refractory oxides. Author (TAB)

N67-29482# CBS Labs., Stamford, Conn.
DEVELOPMENT OF A HIGH-SPEED LOW JITTER SCANNING TECHNIQUE FOR APPLICATION TO RADAR SIMULATION Final Report, Jan.–Jul. 1966
I. Shim Wright-Patterson AFB, Ohio, AMRL, Nov. 1966 54 p
(Contract AF 33(615)-3458)
(AMRL-TR-66-176; AD-650322) CFSTI: HC $3.00/MF $0.65

A breadboard model scanner was modified to incorporate a six-lens, rotating optical scanning system and sync. pulse generation circuitry. The modified scanner consists of a laser light source, a beam expander, a beam normalizer, a six-lens, air-bearing, rotating optical scanning system, a holder for a 2-inch-wide transparency, a light collector, a photomultiplier assembly, a video amplifier, sync. pulse generation circuits and a high voltage power supply. Using a laser source to generate a small optical spot, a capability of distinguishing 200 1P/MM and 30 shades of grey from light to dark was demonstrated while maintaining the jitter along the sweep and perpendicular to the direction of sweep of one-fourth of a spot diameter. Author (TAB)

N67-29542# Pacific Missile Range, Point Mugu, Calif.
LASER RADAR RETURNS FROM THE LOWER TROPOSPHERE COMPARED WITH VERTICAL OZONE DISTRIBUTIONS
J. L. Karney, D. A. Lea, and C. A. Knudsen 27 Mar. 1967 16 p refs
(PMR-TM-67-2; AD-649700) CFSTI: HC $3.00/MF $0.65

Development of operational meteorological applications for laser radars has generally been handicapped by a lack of direct measurements of atmospheric conditions associated with back-scattering of laser pulses. In an attempt to provide an adequate description of the ambient atmospheric structure, operation of a Q-switched ruby laser has been coordinated with simultaneous and near-simultaneous observations from a variety of standard as well as nonconventional meteorological data systems. Significant similarities appear between aerosol-backscattered laser returns from the lower troposphere and vertical ozone profiles obtained by balloon-borne chemiluminescent ozonesondes. The ozone profiles aid interpretation of the laser returns and permit improved delineation of atmospheric strata, especially in smoggy air advected from the nearby Los Angeles Basin. Author (TAB)

N67-29593# h nu Systems, Inc., Menlo Park, Calif.
LASER PARAMETER MEASUREMENTS HANDBOOK, VOLUME II Final Report
H. G. Heard Feb. 1967 235 p refs
(Contract AF 30(602)-3346)
(RADC-TR-66-704, Vol. II; AD-650871) CFSTI: HC $3.00/MF $0.65

The Laser Parameter Measurements Handbook is a compendium of measurement that encompasses the laser technology. It includes a wealth of information gleaned from over 650 articles surveyed in an exhaustive literature search that reviewed American as well as foreign scientific journals, and Government reports. This work contains the contributions of 37 authors whose works were edited to conform with the text and abridged to eliminate redundancy. It is believed that the text treats all of the significant laser measurement techniques that have been published to date in the areas of beam sampling, beam parameters, power, energy, gain, wavelength, bandwidth, coherence and frequency stability. The techniques of modulation and the methods of measurement are treated as are the communication aspects of noise in the laser signal source. This volume contains chapters entitled: Measurement of gain parameters; Measurement of wavelength. TAB

N67-29595# h nu Systems, Inc., Menlo Park, Calif.
LASER PARAMETER MEASUREMENTS HANDBOOK, VOLUME I Final Report
H. G. Heard Feb. 1967 387 p refs
(Contract AF 30(602)-3346)
(RADC-TR-66-704, Vol. I; AD-650870) CFSTI: HC $3.00/MF $0.65

The handbook is a compendium of measurement that encompasses the laser technology. It includes a wealth of information gleaned from over 650 articles surveyed in an exhaustive literature search that reviewed American as well as foreign scientific journals, and Government reports. The work contains the contributions of 37 authors whose works were edited to conform with the text and abridged to eliminate redundancy. It is believed that the text treats all of the significant laser measurement techniques that have been published to date in the areas of beam sampling, beam parameters, power, energy, gain, wavelength, bandwidth, coherence and frequency stability. The techniques of modulation and the methods of measurement are treated as are the communication aspects of noise in the laser signal source. This volume contains chapters entitled: Laser parameters and measurement; Beam sampling techniques; Measurement of beam parameters; Measurement of energy and power. TAB

N67-29597# TRW Systems, Redondo Beach, Calif.
ABLATING WALL ANNULAR FLASH LAMP Final Report, Feb. 1966–Jan. 1967
Robert Goldstein, Frithjof N. Mastrup, and William L. Shackleford Wright-Patterson AFB, Ohio, AF Avionics Lab., Mar. 1967 103 p refs
(Contract AF 33(615)-1072)
(AFAL-TR-67-32; TRW-02245-6010-R000, AD-649969) CFSTI: HC $3.00/MF $0.65

A quartz ablating laser pump was constructed and up to 25 kj energy was discharged into it from a pulse forming network with resultant power, current and voltage shapes which closely approximated rectangular 1 msec pulses. The pumps were used to pump ruby and neodymium laser crystals. A quartz ablating repetition rate lamp was constructed and operated at rep rates up to 30 pulses per second and a power dissipation up to 2.4 kw; lamp operation was for at least a minute. In addition, the lamp was used to continuously excite a 1/4 inch diameter by 3 inch neodymium crystal at rep rates up to 6 pps. The ablating lamp research was a continued study of the plasma physical characteristics of Plexiglas and quartz ablating lamps. The latter lamp was tested with Plexiglas and quartz center rods and without a center rod. Quartz ablating lamps were used to irradiate several rare-earth doped laser crystals. Laser emission below 1.1 microns was observed from some of these rods. In particular, emission at 8465 plus or minus 25 A was obtained from a CaF2 (10% ErF3, 0.5% TmF3) crystal; this emission had never before been obtained using standard flash lamps. Finally, the maximum radiative efficiency of a 30 inch long quartz ablating lamp with a pulse duration of 35 microsec was found to be about 30%. Author (TAB)

N67-29625# North Carolina State Univ., Raleigh. School of Physical Sciences and Applied Mathematics.
STUDIES OF CENTERS PRODUCED IN SAPPHIRE AND RUBY BY GAMMA RADIATION. PART III Final Report
Charles R. Philbrick, Grover C. Cobb, William C. Collins, William R. Davis, Benjamin T. Gravely et al Dec. 1966 112 p refs
(Contract DA-01-021-AMC-13339(Z))
(AD-650122) CFSTI: HC $3.00/MF $0.65

Centers produced by the gamma irradiation of laser crystals are known to strongly affect laser characteristics. The centers produced by gamma radiation in sapphire and ruby crystals were studied using several experimental techniques. The optical absorption of gamma-radiation-induced center bands was studied using plane polarized light to investigate the optical properties along axes perpendicular and parallel to the C-axis. This technique permits determination of the anisotropy of the radiation-produced centers.

The detailed studies of the optical center bands contributed to the identification of the various components of the center band structure. In addition, the results of studies of glow curve measurements, thermoluminescent emission spectra, electrical conduction and step annealing are reported and discussed for the case of centers produced in ruby and sapphire crystals by gamma radiation. Also, the thermal activation energies of the traps associated with the sapphire centers were calculated by three different methods and found to be in good agreement. Author (TAB)

N67-29666# Sylvania Electric Products, Inc., Mountain View, Calif. Electric Defense Labs.
TECHNIQUES FOR SUPER-MODE OSCILLATION Interim Engineering Report, 1 Jan.–31 Mar. 1967
Russell Targ, D. E. Caddes, and P. J. Titterton Mar. 1967 47 p refs
(Contract AF 33(615)-2884)
(IER-7; AD-649903) CFSTI: HC $3.00/MF $0.65

The report discusses a modulation procedure which will be used to obtain pulsing, mode-locked operation from the CO2 laser. An analysis is presented to explain the mechanism by which multimode output from this normally single-frequency laser is obtained. An estimate is given of the enhancement in peak pulse power to be expected, as compared with the previous cw laser power. An analysis is also given for possible mode-locked or FM operation of the GaAs diode laser. Author (TAB)

N67-29672# Brandeis Univ., Waltham, Mass.
QUANTUM THEORY OF INTERNALLY MODULATED LASERS Scientific Interim Report
Paul J. Titterton Feb. 1967 132 p refs
(Contract AF 19(628)-5833)
(SR-4; AFCRL-67-0119; AD-649851) CFSTI: HC $3.00/MF $0.65

Recent experiments have revealed two distinct modes of operation of the internally modulated laser, the am and fm modes, each of which removes almost all random phase and amplitude fluctuations in the laser output. A quantum theory of the modulation process is developed in terms of the travelling wave modes of an optical resonator. The theory predicts the effect of the modulator on an arbitrary wave packet of electromagnetic energy. A saturation analysis of the steady state operation of both the am and the fm laser is performed in an effective linear response approximation. Effective gain curves are found and plotted for multimode am, single mode am and single mode fm cases. Experiments are suggested to test details of the modulation process whose effects are revealed by this analysis. Author (TAB)

N67-29678# Naval Research Lab., Washington, D. C.
LASER MATERIALS RESEARCH Memorandum Report
H. W. Gandy, R. J. Ginther, and J. F. Weller Jul. 1966 85 p refs
(ARPA Order 306; ARPA Order 660)
(NRL-MR-1713; AD-649670) CFSTI: HC $3.00/MF $0.65

Studies of non-radiative energy transfer in doubly and triply activated glasses are reported. The utilization of this energy transfer in stimulated emission processes in these glasses has been investigated and has yielded expected benefits as well as somewhat unexpected results. Some of these effects are: mutual quenching of coactivator luminescence preventing the stimulated emission of either activator species, controllable selection of the lasing species in doubly and triply activated glass, internal or self Q switching, and ultraviolet radiation-induced modulation of stimulated emission. Author (TAB)

N67-29837# Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant.
INDUSTRIAL LASER POSITIONING APPLICATIONS
R. W. Schede 6 Mar. 1967 22 p refs Presented at the Am. Ordnance Assoc., Std. and Metrology Div. Meeting, Gaithersburg, Md., 12–13 Apr. 1967
(Contract W-7405-ENG-26)
(Y-DA-1587; CONF-670404-1) CFSTI: HC $3.00/MF $0.65

The basic characteristics, operational characteristics, accuracy, machine mounting, and performance of the laser interferometer are discussed. NSA

N67-30020# Marine Engineering Lab., Annapolis, Md.
EXPERIMENTAL TECHNIQUES FOR MEASURING VIBRATIONS USING A LASER INTERFEROMETER
R. A. Darby Mar. 1967 54 p refs
(TM-9/67; AD-650720) CFSTI: HC $3.00/MF $0.65

Existing and some apparently novel experimental techniques for measuring vibrations by use of a HeNe gas laser interferometer are evaluated. Schemes for obtaining accurate, absolute measurements of displacements less than 100 A, such as used in calibrating accelerometers, are considered as well as are methods of scanning a vibrating surface in order to obtain its dynamic displacement profile, as is often desired in acoustic radiation studies. The effect of intensity fluctuations of the light source, variations of the medium in the optical paths, background vibrational noise, and other phenomena are evaluated by comparison of the theory with measurements made on both a vibrating elastic plate and a vibration shake table. It is shown that experimental measurements at low displacements ($<<1938$ A) can be compared with theory without resorting to statistical evaluations of instrument error and undesired time-variant parameters. Author (TAB)

N67-30180# Technical Operations Research, Burlington, Mass.
CONTACT PRINTING WITH COHERENT LIGHT Final Report, 7 Apr. 1965–30 Sep. 1966
Edmund L. Bouche and Donald A. Servaes Griffiss AFB, N. Y., RADC, Mar. 1967 83 p refs
(Contract AF 30(602)-3842)
(TO-B-66-89; RADC-TR-66-473; AD-651925) CFSTI: HC $3.00/MF $0.65

Investigation of coherent light printing included the consideration of both beam swinging and fixed illumination systems, and the latter was chosen for use on the modified Kodak Concord continuous contact printer. A technique was adopted whereby a cylindrical glass rod was used as both pressure roller and optical element, permitting good line contact and eliminating interference patterns. A 5.9mm focal length planoconvex lens fans out the laser beam in one direction while the glass rod converges the fanned-out beam to a line at the printing platen. The GFE printer was modified to use a 1W Raytheon LG-12 Argon ion laser as a light source. As the laser is operated at full power, a glass wedge, of the type used on Joyce-Loebl densitometer, is used to attenuate the beam to prevent burning. The spectral response of several films relative to the lines present in the Argon laser was determined so that SO 242 should be 2.2 times more sensitive than SO 8430 and that 3404 should be 22 times more sensitive than SO 8430. Evaluation of results demonstrated that resolutions higher than those specified for the films by their manufacturer can be recorded with the coherent printer. Author (TAB)

N67-30310# Rochester Univ., N. Y. Inst. of Optics.
DOPPLER OPTICAL RADAR AND THE HETERODYNE MEASUREMENT OF OSCILLATING SYSTEMS
James Terrence Montonye (M.S. Thesis) 1967 89 p refs
(Contract TCG-09184-A)
(AD-651822) CFSTI: HC $3.00/MF $0.65

The measurement of oscillating systems is presented as a prelude to an investigation of Doppler optical radar. The radiation from a single-mode gas laser is used successfully by Doppler optical heterodyne techniques to measure the displacement and

velocity waveforms of a moving-coil loudspeaker and a piezoelectric transducer. Vibrations as small as a twentieth of a wavelength (0.000001 cm) and velocities as low as .1 cm per second are measured. A simple method of synchronization is shown to allow convenient measurement of target tilt or distortion as well as the velocity at any point on the targets displacement waveform. Theoretical considerations covering the statistical nature of radiation from thermal light sources are presented and used to demonstrate the feasibility of mixing either independent or correlated thermal light beams. Laser sources are shown to exhibit qualities (specifically narrow bandwidth and high degeneracy values) not characteristic of thermal sources but which are necessary for Doppler optical heterodyning over long target ranges. While offering resolution and directional advantages over conventional microwave radar systems, Doppler optical radar is restricted by target jitter and diffuse target reflectance which increase signal bandwidth and destroy coherence. A study is made of these effects. Author (TAB)

N67-30353# California Univ., Los Angeles. Dept. of Meteorology.
ATMOSPHERIC TRANSMISSION OF LASER BEAMS Final Technical Report, 1 Jan. 1965–30 Apr. 1966
Zdenek Sekera Apr. 1967 11 p
(Contract Nonr-233(96))
(AD-651388) CFSTI: HC $3.00/MF $0.65

After a thorough survey of the existing literature and experimental facilities available in the area, the program of investigations leading to the study of atmospheric limitations to the propagation of laser beams was outlined. Author (TAB)

N67-30373*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMMUNICATIONS RESEARCH AND DEVELOPMENT
In its Space Programs Sum. No. 37–45, Vol. III for the Period Mar. 1 to Apr. 30, 1967 The Deep Space Network 31 May 1967 p 32–58 refs (See N67-30371 17-11)

Error detection procedures for the Deep Space Network (DSN) are discussed, along with the multi-mission telemetry demodulator project. Frequency generation and control projects are concerned with: (1) a phase modulator for testing phase-lock loops of the frequency agile receiver and (2) hydrogen maser frequency standard. Studies of low noise receivers deal with the development of a microwave traveling wave maser. Measurements of X-band gain antenna systems, as well as multi-feed cone system for advanced antenna systems are being studied. M.W.R.

N67-30438# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
DESIGN, CONSTRUCTION, AND STUDY OF A Q-SWITCHED CO_2–N_2–He GAS LASER
Ronald M. Polant, and Thomas H. Lloyd (M.S. Thesis) Mar. 1967 73 p refs
(GE/EE/67A-6; AD-651615) CFSTI: HC $3.00/MF $0.65

An electrically driven mechanical Q-switch was placed in a CO2-N2-He laser vacuum to eliminate Brewster angle window losses. The resonator length was 179 cm. Laser output was produced at 10.6 microns and 9.6 microns with and without tube cooling. For tube temperatures from 273K. to 183K., laser output at 4.35 microns was found to vary approximately as exp(constant/T to the 3/2 power). Cooling the laser tube to 77K. changed the system to a CO laser. When Q-switched, it produced laser oscillation on 73 lines in the vtov-1 bands of the CO X Sigma+ ground state for $3 < or = v < or = 17$. Cascading of these transitions with approximately a 1 microsec time delay was observed. Author (TAB)

N67-30444# TRW Systems, Redondo Beach, Calif.
INVESTIGATION OF LASER RADIATION SIMULATION FOR MICROELECTRONIC DEVICE HARDENING Final Report, 15 May–15 Nov. 1966
D. A. Mc Williams, C. H. Skeen, J. L. Buie, G. L. Sandberg, R. G. Downing et al 27 Jan. 1967 93 p refs
(Contract AF 19(628)-5910)
(TRW-06414-6001-R000; AFCRL-67-0102; AD-651412) CFSTI: HC $3.00/MF $0.65

The report presents the results of a study to determine the feasibility of using a Q-switched neodynium glass laser to simulate transient radiation effects in silicon electronic devices. A laser system has been constructed utilizing a saturable dye as a passive Q-switching element operating in the 0.1 to 1 joule range with single pulsewidths of 20 to 30 nanoseconds. Equivalent silicon doses ranging up to 100,000 rads silicon can be obtained. An empirical and theoretical correlation has been made between carrier generation of the laser radiation and carrier generation due to flash x-rays in both a photoconductive specimen and a fast linear photo-diode. Further study was made of the effects of Q-switched laser on transistors and integrated circuits. The current pulses measured agree with calculated values. The results are similar to the results of flash x-ray studies made by others. The total absence of RF noise and spurious signals in the laser experiment allowed very precise observation of primary and secondary photocurrents throughout the exposed circuits. The Q-switched laser is a low cost, flexible tool for the study of transient radiation effects in silicon integrated circuits and is suitable for production line testing. Author (TAB)

N67-30458# Princeton Univ., N. J. Frick Chemical Lab.
DESIGN AND CONSTRUCTION OF A LASER RAMAN SPECTROPHOTOMETER
R. E. Miller, D. L. Rousseau, and G. E. Leroi May 1967 48 p refs
(Contract Nonr-1858(27))
(TR-22; AD-651646) CFSTI: HC $3.00/MF $0.65

A summary of the considerations involved in the design and construction of a laser Raman spectrophotometer is presented. The instrument consists of a Spectra-Physics Model 125 He-Ne gas laser excitation source which emits more than 80 mw of power at 6328A, a Spex Model 1400 double monochromator, a cooled Hammamatsu R-136 photomultiplier, and appropriate optics and electronics. Representative Raman spectra are shown, and programs used to obtain wavelength conversion and instrumental dispersion and calibration characteristics are provided. Author (TAB)

N67-30514*# National Engineering Science Co., Pasadena, Calif.
LASER NOISE: THEORY AND EXPERIMENT Final Report
H. Hodara, N. George, and J. Yoh 25 Nov. 1965 53 p refs
(Contract NAS1-6003)
(NASA-CR-66261; S-319) CSCL 20E

Two major noise sources have been identified in dc discharge gas lasers: plasma noise and multimode noise. These sources may lead to a 20- to 30-db increase in noise above the shot noise level in certain bands of the spectrum extending from a few kHz to several MHz. This increase in noise can degrade the performance of an optical communications system. The presence of these noise sources, the spectral location, and the magnitude for several helium–neon lasers investigated is the subject of this report. Experimental results reveal that plasma noise can be reduced by increasing the filament current in the laser tube, and multimode noise can be controlled by inserting an iris in the laser cavity to eliminate off-axis modes. Careful choice of mirror separation and curvature also helps to minimize low frequency noise. Author

N67-30561*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
LASER SYSTEMS RESEARCH AT MARSHALL SPACE FLIGHT CENTER
Charles L. Wyman *In its* Res. Achievements Rev., Vol. I 1967 9 p refs (See N67-30554 17-34)

Laser systems research and development at MSFC have been concerned with communication, guidance, and tracking applications. Described are two laser radar systems which are at an advanced stage of development. One is an airborne optical guidance system for rendezvous maneuvers and the other is a ground-based precision optical tracking system for advanced launch vehicles. In advances beyond this breadboard development, work is being done on room-temperature continuous injection lasers, image dissectors and beam steerers, an optical superheterodyne receiver, a precision gas-bearing tracking mount, and other instruments and techniques. Advantages that are expected to result from the research and development program are a reduction in system size and power requirements, elimination of problems associated with microwave techniques (e.g., ground clutter and backscatter), greatly increased operation range, and very high accuracy in tracking and ranging. Author

N67-30568*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
RESEARCH IN SUPER POWER LASERS AND INTENSE MAGNETIC FIELDS
R. J. Schwinghamer *In its* Res. Achievements Rev., Vol. I 1967 10 p (See N67-30554 17-34)

New tools and tooling concepts based upon MSFC research developments in superpower lasers and intense magnetic fields are investigated for drilling and welding applications. One of the most promising lasers, a pink-ruby type in a coaxial gun, with a Cassegrainian focusing system, has an input power of 240,000 joules and an output of 2000 joules, sufficient for vaporizing any material. Since this welding system operates in a normal ambient pressure while its beam can be projected into vacuum to do work, it has potential for use in space as well as the laboratory and shop. Author

N67-30600*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
HYDROGEN MASER RESEARCH ACHIEVEMENTS AT MSFC
John G. Gregory *In its* Res. Achievements Rev., Vol. I 1967 8 p refs (See N67-30554 17-34)

The basic principles and the construction of a hydrogen maser and its potential as a highly stable frequency reference for precision tracking systems are discussed. Improvements in stability and size are presented and future improvements are proposed. Results of measurements of relative frequency stability of two masers and the comparison of a hydrogen maser and a cesium beam are discussed. Also presented is the status of the hydrogen maser program and possible areas of application. Author

N67-30627 Technisch Documentatie en Informatie Centrum voor de Krijgsmacht, The Hague (Netherlands).
LASERS AND MASERS: MILITARY AND INDUSTRIAL APPLICATIONS—A SELECTIVE BIBLIOGRAPHY, NOVEMBER 1962–NOVEMBER 1966
C. J. de Ruig, comp. Mar. 1967 68 p refs
(TDCK-47999)

This bibliography was compiled from literature available at the TDCK. It refers to the period from November 1962–November 1966 and contains the following subjects: optical radar, rangefinding, navigation, laser velocimeter, laser gyroscope, height measurement, underwater mapping and detection, communication, image forming (holography), detection of laser radiation, laser in industry, safety. Author

N67-30721# Texas Instruments, Inc., Dallas. Apparatus Div.
LARGE-ANGLE DEFLECTION TECHNIQUE FOR LASER DISPLAY Final Report, 29 Apr. 1965–8 Sep. 1966
Charles E. Baker and G. R. Fournier Griffiss AFB, N. Y., RADC, Feb. 1967 83 p refs
(Contract AF 30(602)-3731)
(U4-912008; RADC-TR-66-722; AD-651301) CFSTI: HC $3.00/MF $0.65

The results of a one-year program to develop an improved coherent light beam scanning technique for use in a real-time, projection display system using a laser light source are presented. The basic features of the selected approach are reviewed, and the required system performance is translated into component parameters. Progress in techniques critical to the design of a successful system such as torsionally resonant light beam scanners is described. This report is concluded by analysis of system performance and a discussion of future potential. Author (TAB)

N67-30726# Massachusetts Inst. of Tech., Cambridge.
STUDY OF VARIOUS ASPECTS OF RAMAN SCATTERING USING CONTINUOUS WAVE OPTICAL MASERS Semiannual Technical Summary Reports No. 2 and 3, 1 Feb. 1966–31 Jan. 1967
Ali Javan, Paul A. Bonczyk, Ronald H. Cordover, and John R. Murray 5 Apr. 1967 24 p refs
(Contract Nonr-3963(22); ARPA Order 306)
(AD-650044) CFSTI: HC $3.00/MF $0.65

A report is given of the continuation of earlier experiments on motional narrowing of the linewidth of Raman scattering in hydrogen molecules. This narrowing, which has now been observed in spontaneous Raman scattering is being studied in detail. The report contains also details of the instrumentation of the Raman spectrometer which utilizes a single mode, frequency stabilized, high power argon laser. Also reported is the development and application of a new spectroscopic technique to ultra-high resolution studies of atomic line centers. It involves a line narrowing effect induced by laser radiation and the measured quantities are precise values of isotope shifts in levels of NE. Author (TAB)

N67-30731# Minnesota Univ., Minneapolis. Dept. of Electrical Engineering.
NONLINEAR INTERACTION OF LASER RADIATION Semiannual Technical Report, Feb.–Aug. 1966
J. A. Carruthers and R. J. Collins Aug. 1966 23 p refs
(Contract DA-31-124-ARO(D)-402; ARPA Order 675; Proj. Defender)
(AROD-6038-2-P; SATR-2; AD-651807) CFSTI: HC $3.00/MF $0.65

Progress is reported on the two aspects of nonlinear optics which are being studied under the contract. These are: laser-induced gas breakdown, and a study of parametric amplification at optical frequencies. Author (TAB)

N67-30815*# Ohio State Univ., Columbus. Electroscience Lab.
RECEIVER TECHNIQUES AND DETECTORS FOR USE AT MILLIMETER AND SUBMILLIMETER WAVE LENGTHS Semiannual Status Report
C. A. Levis 4 May 1967 13 p refs
(Grant NsG-74-60)
(NASA-CR-84863; Rept.-1093-35) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The research activity has been concentrated in the following areas: (a) determination of the exact molecular force constants of CO_2 molecule; (b) solution of the second order coupled linear differential equation which arises from the calculation of excitation cross section of CO_2; and (c) experimental work on infrared lasers.

Consideration was given to the fact that the vibrational states of the CO_2 molecule are not pure independent states but are rather mixed. This is due to the nonlinearities in the vibrational Hamiltonian of the CO_2 molecule. This consideration forces one to first determine the exact eigenstates of the CO_2 molecule. For this purpose, matrices up to 48 by 48 were diagonalized. To do so one should have the correct set of force constants, and this problem is discussed. The problem of solving the resulting equations for the calculation of the excitation cross section is also discussed. Author

N67-30840# Sandia Corp., Albuquerque, N. Mex.
PHOTOMULTIPLIER DETECTORS FOR LASER INTERFEROMETRY
R. E. Hollenbach Feb. 1967 14 p refs
(Contract AT(29-1)-789)
(SC-DR-66-2689) CFSTI: HC $3.00/MF $0.65

A device is required that will detect the light fringes from a Michelson interferometer when one of the two mirrors is moving rapidly. Two multiplier phototubes were tested for this application. One is useful for mirror velocities up to 100 ft/sec, while the other is usable for velocities up to 500 ft/sec. Suggested circuits for operating both tubes are presented. Author (NSA)

N67-31105 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
NEW TRAJECTOGRAPHY ARRANGEMENTS [NOUVEAUX DISPOSITIFS DE TRAJECTOGRAPHIE]
Roland Moreau 1967 40 p refs In FRENCH Presented at the Meeting of the French Soc. of Electricians and Radioelectricians, Paris, 21 Nov. 1966
(TP-446(1967))

Two systems were developed for trajectory analysis, one based on the atomic clock, and the other utilizing ruby lasers. Atomic clocks afford greater simplicity in study methods through their strategic placing of synchronous oscillators. The use of ruby lasers permits greater precision in determining various trajectories. Mathematical expressions and schematics complement the experimental data. Transl. by R.LI.

N67-31305*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
PARAMETRIC ANALYSIS OF MICROWAVE AND LASER SYSTEMS FOR COMMUNICATION AND TRACKING Quarterly Report, 6 Dec. 1966–6 Mar. 1967
L. S. Stokes and K. L. Brinkman 1967 123 p refs
(Contract NAS5-9637)
(NASA-CR-85873; P67-82; HAC-A7747; QR-6) CSCL 09F

The parametric analysis of microwave and laser systems for communication and tracking is to be conducted in two phases. During the sixth quarter effort was expended on refinement of portions of the methodology section and updating of the heat radiator systems section. Author

N67-31658*# Hughes Research Labs., Malibu, Calif.
INVESTIGATION OF THE POTENTIALITIES OF PHOTOCHEMICAL LASER SYSTEMS. PART I: SURVEY AND ANALYSIS Final Report, 1 Feb. 1966–31 Jan. 1967
C. R. Giuliano, L. D. Hess, and J. D. Margerum 31 Jan. 1967 152 p refs
(Contract NAS12-94)
(NASA-CR-85005) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Photodissociative laser systems are proposed and evaluated with regard to their potential for conversion of solar radiation to monochromatic coherent emission. Spectroscopic and photochemical properties of several molecules which absorb light in the visible and near ultraviolet regions are reported, discussed, and compared with requirements for obtaining laser action. Additional mechanisms for achieving population inversions in these systems indirectly, such as Franck–Condon pumping and association processes stabilized by stimulated emission, are also discussed. Preliminary experimental studies are reported for methyl iodide and bromide, iodo- and bromocyanogen, iodine bromide, and nitrogen dioxide. Laser action was observed under a variety of experimental conditions from CF_3I and NOCl, but could not be detected in the initial studies conducted with other compounds. Chemical reversibility was demonstrated for the nitrosyl chloride system using mixtures of molecular chlorine and nitrosyl chloride. Author

N67-31672# Library of Congress, Washington, D. C. Aerospace Technology Div.
FOREIGN SCIENCE BULLETIN, VOLUME 3, NO. 4 Monthly Review of Selected Foreign Scientific and Technical Literature
Apr. 1967 132 p refs
CONTENTS:

1. SPACECRAFT CABIN ATMOSPHERES. A REVIEW OF SOVIET LITERATURE B. Mandrovsky p 1–37 refs (See N67-31673 18-31)
2. RECENT SOVIET RESEARCH ON TROPOSPHERIC COMMUNICATIONS B. Doncov p 38–51 refs (See N67-31674 18-13)
3. FIBER-OPTICS LASER WITH NONRESONANT FEEDBACK Y. Ksander p 52–57 refs (See N67-31675 18-16)
4. THERMAL AND THERMAL–OXIDATIVE DEGRADATION OF SOME HEAT-RESISTANT POLYMERS B. Nartsissov p 58–68 refs (See N67-31676 18-18)
5. BIOLOGICALLY ACTIVE ORGANOTIN AND ORGANOLEAD COMPOUNDS AND POLYMERIC MATERIALS S. Markov p 69–87 refs (See N67-31677 18-06)

N67-31675# Library of Congress, Washington, D. C. Aerospace Technology Div.
FIBER-OPTICS LASER WITH NONRESONANT FEEDBACK
Yuri Ksander *In its* Foreign Sci. Bull., Vol. 3, No. 4 Apr. 1967 p 52–57 refs (See N67-31672 18-34)

Preliminary results of the first Soviet experimental glass fiber laser with nonresonant feedback are presented. The device, which consists of a bundle of thin unpolished Nd^{3+}-doped glass fibers, emits monochromatic, coherent radiation at $\lambda = 0.06\ \mu$. Author

N67-31679# Naval Ordnance Lab., Corona, Calif.
FOUNDATIONAL RESEARCH PROJECTS Quarterly Report, Oct.–Dec. 1966
15 Mar. 1967 108 p refs
(NOLC-705; AD-651544) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. MAGNETO–OPTICAL OBSERVATIONS WITH PULSED ARGON LASER LIGHT J. L. Tomlinson p 1–3 refs (See N67-31680 18-16)
2. CONVERGING DETONATIONS R. L. Conger p 5–18 refs (See N67-31681 18-25)
3. CORRECTIONS TO THE SAHA EQUATION C. A. Roberts p 19–35 refs (See N67-31682 18-25)
4. TWO-PHONON MATRIX ELEMENTS AND ABSORPTION FOR CRYSTAL MODELS WITH ZINC BLENDE STRUCTURE A. Nedoluha p 37–47 refs (See N67-31683 18-26)
5. OPTICAL CONSTANTS OF GERMANIUM IN THE SPECTRAL REGION FROM 2.40 TO 3.85 eV R. F. Potter p 48–60 refs (See N67-31684 18-26)
6. TRANSMITTANCE AND REFLECTANCE OF INFRARED OPTICAL MATERIALS FROM 2. TO 50 MICRONS D. E. McCarthy p 61–65 refs (See N67-31685 18-26)

7. OPTICAL SPECTRUM OF EuF_3 H. H. Caspers, H. E. Rast, and H. R. Marlin p 67–101 refs (See N67-31686 18-26)

N67-31680# Naval Ordnance Lab., Corona, Calif. Electricity and Magnetism Div.

MAGNETO-OPTICAL OBSERVATIONS WITH PULSED ARGON LASER LIGHT

John L. Tomlinson *In its* Foundational Res. Proj. 15 Mar. 1967 p 1–3 refs (See N67-31679 18-26)

Magnetic domain patterns 1 cm^2 were observed photographically on a FeCoNi film by means of illumination from a pulsed argon laser. Although uneven illumination resulted in less contrast than is desirable, the process offers the possibility of being used for high speed magneto-optical observations. Author

N67-31738*# Rochester Univ., N. Y. Dept. of Electrical Engineering.

STUDY OF CW GASEOUS LASERS FOR SPACE COMMUNICATIONS Semiannual Status Report, 1 Jul.–30 Nov. 1966

Hideya Gamo and Toshiharu Tako 1 Dec. 1966 13 p
(Grant NGR-33-019-048)
(NASA-CR-83577; SASR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The development of a CW gaseous laser which has potentialities for space communications. The He–Xe 3.5 micron gaseous laser was chosen since its line falls in one of the best atmospheric windows, and its gain is the highest known to date, 4 db/cm, although its output power is not very high. Excellent frequency stabilized Xenon laser is expected from the facts that the Doppler line width is narrow and the laser can oscillate in the low pressure where the pressure broadening is negligibly small. By applying the laser amplifier to the output of a frequency stabilized Xenon laser, a relatively high power laser beam is obtained. Author

N67-31950*# Geological Survey, Washington, D. C.

SPATIAL FILTERING OF ASTRONOMICAL PHOTOGRAPHS

Robert L. Wildey *In its* Astrogeol. Studies, Part A Dec. 1966 p 169–181 refs (See N67-31934 18-30)

The applicability of Fourier transform techniques to problems of astronomical imagery is discussed, and an auxiliary device which destroys the coherence of laser light while preserving its plane waveform is described. The device consists of a Dove prism mounted in a cylinder and rotated by an oblique feed of compressed air. A stationary beam entering one end of the prism emerges from the other end with a rotational velocity twice that of the prism. The device destroys the coherence of the light for time intervals of the order of many prism revolutions or longer because (1) the optical figure of the prism is not perfect, and (2) the rotational motion of the device is not smooth to the extent of being without positional perturbations of the order of a fraction of the wavelength of light or larger. The perturbations considered do not constitute a severe departure from plane waveform. Thus, the optical system continues to operate as it should, except that all lenses have transfer functions without discontinuities so that the Fourier series representations of the images have higher harmonics attenuating to zero even after truncation and thus do not show ringing. An example of the success with which the device destroys coherence, and thus facilitates the application of spatial filtering to astronomical photographs, is included. S.C.W.

N67-32022# Cornell Univ., Ithaca, N. Y. School of Electrical Engineering.

CHARACTERISTICS OF THE STOKES EMISSION IN THE STIMULATED BRILLOUIN SCATTERING PROCESS Interim Scientific Report

C. L. Lang 30 Oct. 1966 61 p refs
(Contract AF 19(628)-5677)
(AFCRL-67-0051; SR-1; AD-653210) CFSTI: HC $3.00/MF $0.65

The characteristics of the Stokes emission in the stimulated Brillouin scattering of intense laser light in non-focusing media were studied in detail both theoretically and experimentally. Simple formulas that describe the various characteristics of the Stokes emission are obtained for the case when the attenuation length of the microwave phonons involved is much shorter than the interaction length and the distance over which the Stokes intensity in the medium changes appreciably due to the stimulated Brillouin process. This condition is generally fulfilled in most room-temperature experimental situations; these results can, therefore, be used as a convenient basis for interpreting the experimental results. Stimulated Brillouin scattering of collimated ruby laser beams in such non-focusing liquids as n-hexane, methanol, and carbon tetrachloride was investigated. It was found that the experimental data obtained is in very good agreement with the calculated results obtained on the basis of the simple steady state theory given. Author (TAB)

N67-32126# Army Environmental Hygiene Agency, Edgewood Arsenal, Md.

LASER HAZARDS BIBLIOGRAPHY

David H. Sliney and William Palmisano Apr. 1967 25 p refs
(AD-652707) CFSTI: HC $3.00/MF $0.65

The bibliography provides a source of references for those interested in the biological effects and the evaluation of hazards associated with laser equipment. The references are categorized into six principal sections: General Information; Biological Effects - General Research; Skin Effects; Eye Effects; Safety and Protective Equipment and Procedures; and Atmospheric Attenuation of Laser Beams. TAB

N67-32164*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.

PARAMETRIC ANALYSIS OF MICROWAVE AND LASER SYSTEMS FOR COMMUNICATION AND TRACKING Quarterly Report, 6 Aug.–6 Nov. 1965

30 Nov. 1965 129 p ref
(Contract NAS5-9637)
(NASA-CR-74989; P65-149; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 17B

This report describes the work performed during this period on a parametric analysis of microwave and laser communication and tracking systems. Information and conclusions of previous studies were acquired and critiqued. The critiques list the significant contributions of each study and the location of the material within the body of the report. The critiquing has been completed for telecommunications and is in progress for the acquisition and tracking portion. Progress is reported on the three sections of a space design handbook. These sections include a methodology for solving space communication and tracking problems, parametric studies of the parameters involved in the methodology, and a state-of-the-art documentation of the parameters values. R.N.A.

N67-32165*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.

PARAMETRIC ANALYSIS OF MICROWAVE AND LASER SYSTEMS FOR COMMUNICATION AND TRACKING Quarterly Report, 6 Mar.–6 Jun. 1966

Jun. 1966 387 p refs
(Contract NAS5-9637)
(NASA-CR-77943; P66-135; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Five technical sections of the first issues of reference data for advanced space communications and tracking systems are updated. The sections include mission analysis, transmitting power

sources, optical modulators, acquisition and tracking, and background radiation and atmospheric attenuation. Manned and unmanned space missions envisioned over the next several decades are summarized. The primary objectives of each mission are described and implied communication requirements are discussed. The transmitting power sources section is enlarged in the area of solid state power sources in the microwave region and in the area of CO_2 laser technology in the optical region. Acquisition and tracking efforts were directed towards documentation of the basic constraints within which an acquisition and tracking system must operate and an examination of the constraint effects on some general configurations. Some of the more important advances in optical modulation which are currently in progress are discussed and a section on elasto-optic modulation has been added. Current information concerning external noise sources relevant to optical and microwave space communication systems is presented. R.N.A.

N67-32166# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
PARAMETRIC ANALYSIS OF MICROWAVE AND LASER SYSTEMS FOR COMMUNICATION AND TRACKING Quarterly Report, 6 Jun.–6 Sep. 1966
6 Sep. 1966 410 p refs
(Contract NAS5-9637)
(NASA-CR-82101; P66-213; QR-4) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Reference data for advanced communications and tracking systems are presented to provide a methodology for solving space communication and tracking problems, parametric studies of the parameters involved in the methodology, and a state-of-the-art documentation of the parameter values. In addition, an evaluation is made of the capability and amenability to modification of the available communication and tracking systems to the increased performance requirements of future microwave and optical communications systems. The presentation covers communication theory along with an analysis of the modulation, detection, and coding processes of communication systems; the performance and theory of radio frequency and optical detectors; acquisition and tracking with emphasis on a narrow beamwidth optical problem; radio frequency antennas for space and earth based applications; and key parameters and systems concepts of previous communications systems designs for comparison purposes. R.N.A.

N67-32189# Stanford Univ., Calif. Microwave Lab.
MICROWAVE RESEARCH Quarterly Status Report, 1 Aug.–31 Oct. 1966
Nov. 1966 19 p refs
(Contract Nonr-225(48))
(ML-1491; QSR-31; AD-645239) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. OPTICAL MASER RESEARCH A. L. Schanwlow, R. M. Macfarlane, and S. Johnson 9 p refs (See N67-32190 18-16)

2. GENERATION OF A DOMAIN IN CADMIUM SULFIDE BY INJECTED ACOUSTIC NOISE W. H. Haydl 10 p refs (See N67-32191 18-26)

N67-32217*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
ELECTRON AND SOLID STATE PHYSICS
H. Brooks, N. Bloembergen, P. S. Pershan, G. D. Boyd, G. E. Durand et al *In its* Cruft Lab. Mar. 1967 12 p refs (See N67-32215 18-34)
(Contracts ARPA SD-88; Nonr-1866(28))

Second Harmonic Generation (SHG) of light by a Q-switched laser beam from the surface of various metals was investigated. SHG was observed from liquid Hg, single crystal Sb, and single crystal Bi. Phase matching studies of nonlinear electroreflectance in silicon and silver of fundamental and second harmonic reflections, are also reported. Other work is reported on 1) optical properties of liquid crystals, 2) stimulated Raman effects, 3) carbon dioxide laser nonlinear optical investigations, 4) stimulated Brillouin effects, 5) optically induced magnetizations in paramagnetic crystals, 6) optical spectroscopy of divalent rare earths in ionic crystals, 7) semiconducting properties in rare earth doped CdF_2, 8) magneto–optical effects in solids, 9) Raman spectroscopy from mixed and from magnetic crystals, 10) electronic effects in transition metal oxides, and 11) band theory of ferromagnetic anisotropy in nickel. L.S.

N67-32277* Wisconsin Univ., Madison. Dept. of Mechanical Enginering.
FLUORESCENT PHOTOGRAPHY OF DROPLETS IN A SPRAY USING A Q-SWITCHED LASER AS A LIGHT SOURCE
John Groeneweg (NASA Lewis Labs.), Hiroyuki Hiroyasu (Toyota C. R. D. Lab., Japan), and Richard Sowls 1 Jul. 1967 26 p refs
(Contract NsG-601)
(NASA-CR-72251) CFSTI: $3.00 CSCL 20E

A method of spray photography is described which utilizes a Q-switched laser light source to excite a fluorescent dye in the liquid being sprayed. In order to obtain a laser wavelength falling within the dye's absorption band, the second harmonic of ruby at 3471Å was generated using a KDP crystal. The workability of the method was demonstrated by taking spray photographs of droplets as small as 10 μ. The types of image fine structure observed are illustrated and discussed. A dynamic size calibration showed that reliable drop size information could be obtained from the spray photographs. Author

N67-32322*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
REFERENCE DATA FOR ADVANCED SPACE COMMUNICATIONS AND TRACKING SYSTEMS
6 Feb. 1966 526 p refs
(Contract NAS5-9637)
(NASA-CR-86910; P66-16) CSCL 17G

Overall systems trade-off studies were conducted in sufficient detail to identify missions which will make the best use of laser/optical, microwave, or a combination of microwave and laser/optical communication and tracking systems. A plan is presented for optimumly integrating such systems into present and future world-wide systems. Systems design criteria and specifications are provided, along with the methodology which provides a basis for determining the optimum system configuration. C.T.C.

N67-32495# Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.
THE INTERACTION OF CHROMIUM IONS IN RUBY CRYSTALS
Richard C. Powell (Ph.D. Thesis—Ariz. State Univ.) Dec. 1966 130 p refs *Its* Phys. Sci. Res. Paper No. 299
(AFCRL-66-830; AD-651914) CFSTI: HC $3.00/MF $0.65

Absorption, excitation, continuous fluorescence, and pulse fluorescence measurements were made on ruby samples with 0.94% and 2.1% Cr+3 in the temperature range from 4.2K up to 700K. The widths, positions, intensities, and lifetimes of the R and N fluorescence lines were determined at numerous temperatures. The results for the temperature dependence of the linewidths are explained in terms of microscopic strains, Raman scattering of phonons by the impurity ions, and direct phonon processes. The results for the lineshifts with temperature are due to the absorption

and emission of virtual phonons. The observed lifetimes of the R and N lines coincide in the temperature range where the systems are thermalized and the observed decays are pure exponentials. At temperatures where the systems are decoupled, an initial rise in fluorescence is observed at the N lines. The subsequent decay has the lifetime of the R lines for a 0.94% sample and the lifetime of the N lines for a 2.1% sample. These results are also explained in terms of energy transfer from single ions to pairs. The effects of reabsorption on the fluorescence spectrum are also discussed. Author (TAB)

N67-32556# Perkin-Elmer Corp., Norwalk, Conn. Electro-Optical Div.
STUDY—FAR INFRARED GENERATOR Final Report, 1 Dec. 1965–30 Apr. 1967
Fritz Zernike 30 Apr. 1967 26 p refs
(Contract Nonr-4680(00))
(PE-TR-8779; AD-652830) CFSTI: HC $3.00/MF $0.65

A description is given of studies aimed at producing a far infrared generator by mixing two laser generated frequencies. Attempts to use two CO2 CW operating lasers proved unsatisfactory. A successful experiment was performed, however, by using a single Q-switched CO2 laser simultaneously radiating at 9.6 and 10.6 microns and focused on an InSb crystal. TAB

N67-32638# Ballistic Research Labs., Aberdeen Proving Ground, Md.
LASER IMPULSE MEASUREMENTS WITH ELECTRONIC DETECTION SYSTEM
Millan D. Stoller Apr. 1967 16 p ref
(BRL-TN-1651; AD-653139) CFSTI: HC $3.00/MF $0.65

An electronic device to determine the swing of a ballistic pendulum when the pendulum is struck by laser radiation is described and its operation analyzed. Author (TAB)

N67-32690# American Optical Co., Southbridge, Mass.
OPTICAL INHOMOGENEITIES IN PUMPED LASERS, VOLUME I Final Report, 1 May 1965–31 Oct. 1966

Studies were conducted to determine the pertinent electromagnetic parameters of the magnetic hammer—workpiece system for the purpose of applying these low inductance configurations to the Saturn V fabrication. Of particular interest were hammers for correcting deformations encountered in linear welds around the vehicle. The emphasis during the studies was on calculations of currents and fields for two-dimensional configurations, the field and force profiles for specified loads, and the problem of current optimization. Results are presented of experiments with prototype dipole hammer systems and a prototype ring hammer. Tests of NASA magnetic forming devices involved the ring hammer, the dipole ridge hammer, and the magnetic flaring tool. The experimental data that were obtained indicate the importance of accurate dimensioning of the conductor geometry. The theoretical and experimental results can be combined to formulate guidelines for the scaling of current and voltage requirements as a function of hammer size. K.W.

N67-32732# Bausch and Lomb, Inc., Rochester, N. Y. Research and Development Div.
LASER DAMAGE STUDY OF THIN FILMS Quarterly Report, 1 Jan.–1 Apr. 1967
Arthur F. Turner and Stanley J. Refermat 1 Apr. 1967 28 p refs
(Contract Nonr-4717(00); ARPA Order 306)
(QR-4; AD-651988) CFSTI: HC $3.00/MF $0.65

A concentrated effort was made, during the fourth quarterly period, to increase the laser damage threshold, E sub t, of aluminum oxide films. This objective was approached empirically. Selected vacuum deposition parameters were varied and the effect on E sub t was observed. E sub t for one-quarter wavelength and thirty-three quarter wavelengths films were increased by a factor of two over previously reported values. The one-half wavelength threshold was increased by a factor of six over the previous value. The one-quarter wavelength threshold spontaneously fell to half its original value two days after manufacture. Author (TAB)

N67-32773# Cornell Univ., Ithaca, N. Y. School of Electrical Engineering.
TEMPORAL COHERENCE AND FREQUENCY VS TIME CHARACTERISTICS OF A Q-SPOILED RUBY LASER
G. J. Wolga 30 Oct. 1966 93 p refs
(Contract AF 19(628)-5677)
(SR-2; AFCRL-67-0052; AD-653213) CFSTI: HC $3.00/MF $0.65

A mode selected, cryptocyanine Q-switched ruby laser was designed, constructed, and operated. The degree of mode selectivity as a function of cryptocyanine loss was studied and an optimum loss was selected. Theoretical work was done to incorporate the cryptocyanine loss into a theory of passively Q-switched lasers. A transient interference experiment was redesigned for operation with a Q-spoiled laser. Data was obtained showing that the rate of change of the laser frequency during the Q-spoiled emission pulse is approximately twenty times the rate of change during a single spike of an ordinary ruby laser. This result tends to confirm a previously stated model for this frequency change which attributes it to direct atomic coupling to lattice strain. The ions are expected to act independently in causing the strain and hence the variation in cavity optical length is expected to be linear in the change in the number of excited states in the laser. Since the rate of change of population inversion during Q-spoiled emission is much larger than for normal lasing it was expected, prior to this work, that a greater rate of change of frequency should be observed. This has now been confirmed. Author (TAB)

N67-32863# Raytheon Co., Waltham, Mass. Research Div.
HIGH POWER GAS LASER RESEARCH Final Technical Report, 15 Mar. 1966–14 Jan. 1967
David R. Whitehouse May 1967 120 p refs
(Contract DA-01-021-AMD-12427(Z))
(S-940; AD-653031) CFSTI: HC $3.00/MF $0.65

The report concerns the investigation and optimization of high power and high efficiency in the cw gas laser utilizing carbon dioxide, nitrogen and helium as the active laser medium. In all cases, the gases are excited by an electrical discharge. In the area of flowing gas lasers, an experimental investigation was made into the unsaturated gain characteristics at 10.6 microns and their dependence on the tube diameter, gas mixing, and flow speed. The measurements were taken with a laser bridge of sufficient resolution to measure the radial profiles of the gain. For the high-power oscillators, determination was made of the dependence of the power on tube length, gas pressure, pumping speed, output coupling, and mode control. For sealed-off lasers, determination was made of the dependence of the output power on the gas mix, pressure, and tube preparation. Some results on the initial phases of long life tests are also included. Much of the data which was accumulated indicates that the present limitations of output power in large bore tubes and sealed-off tubes stem from the heating of the gas by the discharge. This is corroborated by theoretical calculations of the heat transfer and temperature profile in the tube. Author (TAB)

N67-32927# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
IONIZATION OF A CESIUM ATOM BY AN ABSORPTION PROCESS INVOLVING TWO PHOTONS FROM A LASER

BEAM [IONISATION D'UN ATOME DE CESIUM PAR UN PROCESSUS D'ABOSRPTION A DEUX PHOTONS ISSUS D'UN FAISCEAU LASER]
Yves Gontier and Michel Trahin Jan. 1967 35 p refs In FRENCH
(CEA-R-3113)

The expression giving the ionization cross section of an atom, by an absorption process involving two photons produced from a laser beam, is derived. The nonrelativistic case is considered and the dipolar approximation used. The summation over the intermediate states is carried out rigorously by means of a special technique which is described in detail. A method is presented which makes it possible to obtain the numerical solution. Author (NSA)

N67-32979# General Dynamics/Electronics, Rochester, N. Y. Electronics Div.
OPTICAL INTERACTIONS IN RUBY LASERS Final Report, 1 Dec. 1965–31 Nov. 1966
Fred C. Unterleitner and Ying C. Kiang 28 Feb. 1967 70 p refs
(Contract AF 19(628)-5810)
(AFCRL-67-0194; AD-653218) CFSTI: HC $3.00/MF $0.65

The report concerns the initial stages of an investigation into the efficiency of ruby lasers, and the kinetics of energy level populations generated by optical pumping. The work described includes the calibration of absolute spectral response of photodetectors, the measurement of ground state absorption cross sections, and the metastable state absorption cross section at selected wavelengths; also described are the preliminary experiments involving end pumping by ion laser radiation at 5682 A. Efficiency measurements at high metastable state populations could not be made with the ion laser power levels available. Calculations based on the absorption measurements, however, indicate a strong wavelength and polarization dependence of overall pumping efficiency in ruby lasers, with metastable state absorption playing an important role in heat input to ruby during pumping. The effectiveness of high pressure mercury discharges for cw pumping is clarified by this analysis. Author (TAB)

N67-33034# Minnesota Univ., Duluth. Electrical Engineering Dept.
ACTIVE DISTORTION DURING RUBY LASER ACTION
Mylan Radulovich and R. J. Collins Apr. 1967 58 p refs
(Contract Nonr-710-(61))
(TR-5; AD-653060) CFSTI: HC $3.00/MF $0.65

Ruby laser rods were studied with respect to thermal distortions induced by the excitation pump flash. Nonuniform temperature distributions cause optical distortions and prevent the laser beam from realizing its minimum theoretical width (diffraction limit). These variations result from the radial distribution of absorbed energy. The radial gradients produce changes in the index of refraction and optical path length which lead to a lens type behavior by the ruby rod. More uniform pumping would reduce the temperature distributions and consequently diminish this lens effect. Author (TAB)

N67-33044# Hughes Research Labs., Malibu, Calif.
STUDY OF FUNDAMENTAL REQUIREMENTS FOR HIGH BRIGHTNESS RAMAN LASER SOURCES Semiannual Technical Summary Report, 1 Oct. 1966–31 Mar. 1967
F. J. McClung May 1967 27 p refs
(Contract NO0014-67-0206; Proj. Defender)
(AD-653106) CFSTI: HC $3.00/MF $0.65

The study is of SRS in liquids. The production of high brightness Raman devices is possible in liquids; however, the brightness gain over existing laser devices does not appear to be very large. We must exercise care in selection of the material to achieve any semblance of gain. The case for gases is much better. Many unexplained processes occur in H_2 and possibly other gases as well. The brightness gains that could be produced have not yet been determined, and the main effort is now concentrated on this problem. We are also investigating the strange behavior of H_2 in the usual SRS experiments. Author (TAB)

N67-33106# Edgerton, Germeshausen and Grier, Inc., Bedford, Mass.
STUDIES FOR A GEODETIC LASER SYSTEM Final Report, 1 Jul. 1965–30 Apr. 1967
Sumner Ackerman 1 May 1967 28 p refs
(Contract AF 19(628)-5516)
(B-3546; AFCRL-67-0229; AD-652235) CFSTI: HC $3.00/MF $0.65

This report contains a brief summary of photoelectric (range) detection, photographic (direction) detection, and design studies made for a geodetic laser system. It appears feasible to measure the displacement between a ground-based (ruby) laser system and a satellite equipped with retrodirective reflector arrays (such as those on the Explorer and Geos satellites) to an accuracy of 2 arc-seconds in direction and less than 10 meters in range at slant ranges of over 2000 km, using essentially state-of-the-art equipment described herein and in the references. The probability of detection is expected to be greater than 90% without optical tracking, if the direction is known in advance to within approximately 2 arc-minutes and the range to within approximately 1 km. Author (TAB)

N67-33158*# Wheeler Labs., Inc., Great Neck, N. Y.
SUMMARY OF THE DEVELOPMENT OF OPTICAL WAVEGUIDES AND COMPONENTS
E. Ronald Schineller Washington, NASA, Aug. 1967 61 p refs
(Contract NAS12-2)
(NASA-CR-860; Rept.-1471) CFSTI: $3.00 CSCL 09A

An overview is presented on the design, fabrication, and testing of laboratory models of single-mode waveguides and components for laser systems analogous to waveguide systems at microwave frequencies. Fabrication techniques were examined with the objective of developing compact, rugged optical components which are insensitive to environmental conditions. Based on a theoretical analysis of various configurations, the dielectric waveguide was found to be the most attractive due to low loss and adaptability to component design. Experimental models implemented with liquid and solid materials for the core and cladding were found to be in excellent agreement with theory in waveguide sizes up to 100λ. The unique attributes of optical waveguides are assessed in relation to alternative free space or beam techniques for constructing optical systems. Waveguide filter properties and their application in actual systems are discussed, and summary data are provied on the design and experimental evaluation of lasers, modulators, directional couplers, filters, and detectors fabricated in single-mode waveguide. M.G.J.

N67-33206# California Univ., Livermore. Lawrence Radiation Lab.
PHYSICS DEPARTMENT REPORT, JUNE–SEPTEMBER 1966
Sep. 1966 68 p refs
(Contract W-7405-ENG-48)
(UCRL-50001-66-2) CFSTI: HC $3.00/MF $0.65

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5. MATHEMATICAL AND COMPUTATIONAL METHODS R. DeBar p 56 (See N67-33211 19-23)

N67-33210# California Univ., Livermore. Lawrence Radiation Lab.

RADIATION AND PLASMA PHYSICS

K. Nishimura *In its* Phys. Dept. Rept., Jun.–Sep. 1966 Sep. 1966 p 51–55 refs (See N67-33206 19-23)

Radiation and plasma physics research involved an integrated system of 16 lasers to study plasma production by high-powered pulsed lasers. The shape of the evolving plasma was of primary interest and it was found that when the total energy of the focused laser pulses was a few joules (near the threshold for plasma formation) the resulting plasma became approximately spherical within 5×10^{-8} sec. The effect of various parameters on the output energy from a Q-spoiled ruby oscillator was studied. Also studied was the problem calculating the rate of energy transfer between ions and electrons in a plasma. R.Ll.

N67-33284# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Gas Iouizzati.

AMOUNT OF MATTER EMITTED AS A JET FROM A LASER IRRADIATED PELLET

P. Giupponi and R. Gratton Mar. 1967 7 p refs Sponsored in part by EURATOM

(LGI-67-7) CFSTI: HC $3.00/MF $0.65

This paper is an attempt to evaluate what fraction of plasma is emitted in the form of a hypersonic jet when a small solid target is vaporized by a large-pulse, and what fraction expands isotropically. Author (ESRO)

N67-33365*# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

MASER RESEARCH PROGRAM

A. W. Nagy *In its* Res. and Develop. Programs Mar. 1967 2 p refs (See N67-33361 19-34)

Materials preparation and microwave bench measurements are reported for a zero-field traveling wave (TW) maser, for which two fluxed-melt runs were completed with 0.08% iron concentration containing 0.25% and 0.50% lanthanum oxide for modifying crystal growth habit. The second run with charges dry mixed was successful, and confirmed the deleterious effect of too much lanthanum oxide for the slower cooling rates. While crystal quality was no better than for the usual 4°C/hr rates, there were fewer flux inclusions between the crystal planes. Iron-doped alumina rods were prepared to determine optimum iron concentration for the TW maser structure, and the first helium run on the zero-field TW maser was completed following extended bench adjustments to secure reasonably good input and output impedances to the helix. M.W.R.

N67-33464# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RAY PENETRATING INTO THE FUTURE ULTRADISTANT COSMIC COMMUNICATION LIGHT PULSES OF SATELLITES

N. Aleksandrov 21 Feb. 1967 13 p Transl. into ENGLISH from Nauchno-Tekhn. Obshch. SSSR (USSR), no. 8, 1964 p 41–43

(FTD-HT-66-439; TT-67-62146; AD-653962) CFSTI: HC $3.00/MF $0.65

The Lenin Prize for 1964 was presented to Associate Member of the AN SSSR Bentsion Vul and a large group of coworkers for the development of a gallium-arsenide semiconductor laser. The semiconductor laser is almost 100% efficient and its microminiature size holds great promise for use in computers to achieve speeds of tens of billions of operations per second. Direct communication over distances of several light years is considered possible with the use of lasers. Satellites carrying a laser could be easily seen and accurately tracked both day and night. Applications of lasers in radio, telephone and television communications and in chemistry are mentioned. Quantum techniques make possible a construction of clocks accurate to one second in ten thousand years which could be used to conduct relativity experiments. Use of the laser beam as a metal working and surgical tool is mentioned. Long distance, high-efficiency transmission of energy by laser beam, especially in space where the absorbing and scattering effects of the atmosphere are avoided, is considered absolutely essential in the conquest of space. Direct conversion of matter into energy without explosion is possible using quantum devices. Quantum engines may utilize solar energy during space flight. Author (TAB)

N67-34114# RCA Victor Co., Ltd., Montreal (Quebec). Research Labs.

DIAGNOSTICS OF MAGNETOPLASMAS BY LARGE ANGLE LASER SCATTERING Interim Scientific Report

I. P Shkarofsky Wright-Patterson AFB, Ohio, ARL, Jan. 1967 113 p refs

(Contract AF 33(615)-2196)

(ARL-67-0020; AD-653584) CFSTI: HC $3.00/MF $0.65

A review of experiments until 1967 on laser scattering from plasmas is given which indicates that any static magnetic field if present has not been utilized for diagnostics. The Appendix summarises the theory on scattering of electromagnetic waves from an infinite magnetoplasma with arbitrary velocity distributions for electrons and ions. It is shown that one can provide large angle scattering in the plane perpendicular to the magnetic field near certain electrostatic resonances, namely the upper hybrid (when the ratio of plasma to cyclotron frequency is greater than the sq. root of 3) and the cyclotron harmonics. The perpendicular wavenumbers associated with these magnetoplasma resonances can become large. Also the plasma resonance and upper hybrid resonance at low density are discussed. For densities 10 to the 12th power to 10 to the 13th power/cc, temperatures 2000 3000K, and using a 10.6 micron laser, the electron velocity distribution function is obtainable from the form of Landau damping acting on the plasma resonance, whereas collisional damping is usually stronger than cyclotron damping for the other resonances. Also the damping expression for the upper hybrid at high plasma densities suffers from complexities in analysis. All resonances are useful to yield electron density and temperature from the dispersion effects. Author (TAB)

N67-34178# Atomic Weapons Research Establishment, Aldermaston (England).

A 12 CHANNEL, DOPPLER PROFILE SPECTROPHOTOMETER FOR PLASMA SCATTERED LASER LIGHT

A. D. Beach Apr. 1967 37 p ref

(AWRE-O-42/67) HMSO: 9s

A laser/spectrometer combination was developed for the determination of spatially and temporally resolved plasma electron temperatures in the range 200 eV to 4 keV (2 to 40×10^{6}° K). The spectrophotometer described here is an f/2, diffraction grating instrument with a 12 channel, sequenced pulse output, suited for use as a laboratory tool, and compatible with the space requirements of parallel instrumentation observing the same plasma. Author (NSA)

N67-34297# Utah Univ., Salt Lake City. Microwave Device and Physical Electronics Lab.

MEASUREMENT OF ATMOSPHERIC AEROSOLS BY POLARIZED-LASER LIGHT SCATTERING

Roger W. Call, E. Paul Palmer, and Richard W. Grow Jun. 1967 134 p refs
(Grant NSF GP-874)
(UTEC-MD-67-034; NSF-11)

A new method using measurements of light scattered from a polarized laser beam to find the aerosol attenuation coefficient, the aerosol number density and the aerosol size distribution is presented. The method was tested by making measurements from a secondary site distant from the laser transmitter. Results are plotted for attenuation coefficients up to 30 kilometers in altitude. The Rayleigh theory of light scattering by small particles is reviewed for the case of a polarized incident light beam. The Mie theory of light scattering is applied to aerosol scattering, and Mie scattering functions are computed for various aerosol size distributions. Theory is developed for making two-station backscatter measurements using a pulsed ruby laser as a light source. The final solution to the equation for aerosol attenuation coefficients depends only on the angular functions for Rayleigh and Mie scattering and upon the relative voltage responses at the distant receiver for the two separate measurements taken at each altitude. Author

N67-34421# Raytheon Co., Waltham, Mass. Research Div.
RESEARCH STUDY OF A CO_2 LASER RADAR TRANSMITTER Semiannual Technical Summary Report, 1 Nov. 1966–1 May 1967
Perry A. Miles and Frank A. Horrigan Jun. 1967 55 p refs
(Contract N00014-67-C-0264; ARPA Order 306)
(S-970; AD-653725) CFSTI: HC $3.00/MF $0.65

The report concerns the investigation of physical properties of laser amplifiers, using electrically excited mixtures of CO_2, N_2, and He with a view to producing high-power pulse emission with well-controlled temporal and spatial form. The object of this investigation is to design and build such a source with an average power of 1 kw in a form suitable for use as a laser radar transmitter. Designs have been developed for both dc- and pulse-excited amplifiers and the physical quantities of importance in these designs have been measured. The most notable of these are: the signal intensity required to drive an amplifier to saturation, information on the refractive properties of the discharge, the time constant determining maximum pulse repetition rates, both for the input pulse trace and for the pulse excitation process, and the practical gain levels that can lead to self-oscillation in the amplifier. These measurements lead to the choice of a system in which a train of 10–15 μsec pulses at a repetition rate of 10–12 kc is amplified by a 50-meter length of dc-excited power amplifier. Author (TAB)

N67-34516# Stanford Research Inst., Menlo Park, Calif.
LIDAR OBSERVATIONS AT NORMAN, OKLAHOMA Summary Report, 18–23 Jan. 1966
Ronald T. H. Collis Feb. 1966 21 p ref
(Contract Cwb-11244)

Experimental lidar observations recorded at the National Severe Storms Laboratory are summarized. Initial lidar observations of falling snow and of cloud and fog conditions associated with snowfall were obtained. A series of observations were also made in very cold, clear air, and quantitative data were obtained on the changes that took place in the stratification in the airflow. Meteorological data were compared with the lidar data and a preliminary comparison was made between the lidar data and radar data, which were recorded concurrently. Simple graphical plotting, and digital and analog computer techniques were used in analyzing the observational data. Preliminary findings indicate that lidar has the capability of observing and evaluating parameters of the lower atmosphere such as: the coefficient of extinction and its changes; the depth of the low level haze layer and other discontinuities in the aerosol density that may be connected with stratification; and the cloud base. Characteristics of the lidar equipment used in the experimental program are given. E.C.

N67-34688# Institut fur Plasmaphysik G.m.b.H., Garching (West Germany).
AVAILABLE LASER WAVELENGTHS FOR VISIBLE AND NEAR-INFRARED SPECTROSCOPY
C. F. Dewey, Jr. Mar. 1967 16 p refs
(IPP-2/60) CFSTI: HC $3.00/MF $0.65

Recent advances in semiconductor injection lasers and frequency-changing methods have significantly broadened the wavelengths spectrum in which laser energy can be generated. A review of available techniques in the visible and near-infrared is presented. At the present time, it appears possible to produce measurably intense coherent radiation at all wavelengths from 3245 A to over 5μ. Author

N67-34818# Library of Congress, Washington, D. C. Aerospace Technology Div.
FOREIGN SCIENCE BULLETIN, VOLUME 3, NO. 6 Monthly Review of Selected Foreign Scientific and Technical Literature
Jun. 1967 60 p refs

A review is made of Soviet literature on the rare earth element chelates for liquid laser application. Surveys are presented on helium production in the U.S.S.R., investigations in the field of low temperature physics, the function of the Soviet State Committee for Science and Technology, and a profile of the research worker in Hungary. Brief technical notes are included on field rotation noise in magnetic thin films, high intensity molecular gas lasers, Soviet short range radio forecasting service, and the development and present state of seismological investigations and seismological service in Hungary. The proceedings of conferences on the physics of cosmic rays, the physics and technology of high and ultrahigh vacuum, seismology, and the permanent geomagnetic field and paleomagnetism are summarized. R.N.A.

N67-34952# Utah Univ., Salt Lake City. Microwave Device and Physical Electronics Lab.
THE EFFECTS OF BUFFER GAS PRESSURE AND CONCENTRATION ON HOLE BROADENING IN GAS LASER SYSTEMS
Maylin H. Dittmore and Richard W. Grow Jan. 1967 166 p refs
(Grant NSF GK-29)
(NSF-10)

The effects of thermal elastic collisions on upper state excited atoms in a laser system are considered. A model, wherein the atoms are considered to be smooth, frictionless spheres, is employed in a classical treatment of the thermal collisions. The probability of an excited atom being transferred from one position on the inhomogeneously broadened distribution to another is calculated. A periodic approximation of the error integral is used to simplify the expression for the transfer probability. Computer solutions for the two cases of Ne He collisions and Ne Ne collisions are carried out. From the transfer probability functions, the broadening of the natural line width due to hard collisions and the broadening of the holes in the excited atomic distribution due to soft collisions are calculated. It is shown that broadening due to soft collisions is much greater than that due to hard collisions in the 6328Å Ne-He laser system. Measurements of hole widths using the concentration ratio and total pressure as parameters are made on the 6328A Ne-He laser system. Measurements are found to agree well with the calculations. Author

N67-35020*# Hughes Research Labs., Malibu, Calif.
INVESTIGATION OF POTENTIALITIES OF PHOTOCHEMICAL LASER SYSTEMS. PART 2-PRELIMINARY EXPERIMENTAL STUDIES Final Report, 1 Feb. 1966–31 Jan. 1967
Feb. 1966–31 Jan. 1967

C. R. Giuliano, L. D. Hess, and J. D. Margerum 31 Jan. 1967 47 p
(Contract NAS12-94)
(NASA-CR-85006) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Photodissociative laser systems are proposed and evaluated with regard to their potential for conversion of solar radiation to monochromatic coherent emission. Spectroscopic and photochemical properties of several molecules which absorb light in the visible and near ultraviolet regions are reported, discussed, and compared with requirements for obtaining laser action. Additional mechanisms for achieving population inversions in these systems indirectly, such as Franck–Condon pumping and association processes stabilized by stimulated emission, are also discussed. Preliminary experimental studies are reported for methyl iodide and bromide, iodo- and bromocyanogen, iodine bromide, and nitrogen dioxide. Laser action was observed under a variety of experimental conditions from CF_3I and NOCl, but could not be detected in the initial studies conducted with other compounds. Chemical reversibility was demonstrated for the nitrosyl chloride system using mixtures of molecular chlorine and nitrosyl chloride. Author

N67-35324* Perkin-Elmer Corp., Norwalk, Conn. Electro-Optical Div.
GIANT APERTURE TELESCOPE STUDY, PHASE I
Robert W. Jones and Harold S. Hemstreet 12 May 1966 96 p refs Prepared for JPL
(NASA-CR-87987; Rept.-8393) CSCL 17H

Results are presented of the first phase of a study aimed at reducing to practice the use of giant aperture telescopes as ground receivers for spacecraft communications. Two basic high data rate communication systems are considered. One uses intensity detection and the other utilizes coherent or heterodyne detection. A communications comparison was made of the two systems to make recommendations for ground station requirements in terms of engineering feasibility, areas for further study or development, and cost. Atmospheric effects were studied and an attempt was made to predict the maximum useful aperture diameter for coherent systems at several wavelengths. Consideration was given to several different mechanical configurations of both the intensity detection receiver and the coherent systems. Results show that either incoherent ground receivers with apertures of ten meters or 10.6 micron region coherent receivers with apertures of four meters are feasible. R.N.A.

N67-35330# Army Electronics Labs., Fort Monmouth, N. J.
CO_2 MOLECULAR GAS LASER
Charles J. Bickart and John N. Fulton Mar. 1967 43 p refs
(ECOM-2818; AD-654518)

The report discusses the experimental results and optimization of a relatively high-power, high-efficiency CW gas laser utilizing a dc excited discharge with a flowing combination of carbon dioxide, helium, and nitrogen as the active laser medium. Continuous laser power output of 126 watts has been measured from a system of 4.7 cm diameter by 2.4 meters long. Details of the various cavity configurations, reflector materials, power coupling-out methods and current characteristics of the discharge are discussed. A 90 degree folded design cavity is described including some intra-cavity Q-switching experiments. These experiments are part of a continuing study of the technology concerning design, construction and optimization of CO2 lasers. Author (TAB)

N67-35382# Florence Univ. (Italy).
MODES IN STABLE AND UNSTABLE REGIONS OF THE FLAT-ROOF OPEN RESONATOR
P. F. Checcacci, A. Consortini, and A. M. Scheggi Feb. 1967 54 p refs
(Contract AF 61(052)-871)
(AFCRL-67-0357; SR-5; AD-654319)

The integral equation of a flat-roof resonator is solved by the Fox and Li method of iterations in a number of particular cases. Mode patterns, phase shifts and power losses are derived as functions of the roof angle and of mirror aperture. A good over all agreement is found with the approximate theory previously developed by Toraldo di Francia. High loss regions are also observed. The behavior of different modes in such regions is investigated in detail. Experimental tests carried out on a X-band model give a confirmation of the theoretical predictions. Author (TAB)

N67-35537# Zaret Foundation, Inc., Scarsdale, N. Y.
OPHTHALMIC HAZARDS OF MICROWAVE AND LASER ENVIRONMENTS Annual Progress Report, 1 Jun. 1966–31 May 1967
Milton M. Zaret 31 May 1967 12 p
(Contract DA-49-193-MD-2592)
(AD-654523) CFSTI: HC $3.00/MF $0.65

The purpose of this investigation is to determine the nature and scope of radiation hazards and to recommend the requisite parameters for health-safety. For both microwave and laser radiation, ophthalmic pathology is the most sensitive indicator of injury. Threshold changes are produced in the lens with microwave radiation and in the retina with laser radiation. As the threshold lesions are not obvious in routine ophthalmic examination, special techniques are under development not only to permit discovery of the earliest occurrence of the injury but also to document the findings. Author (TAB)

N67-35538# Honeywell, Inc., Hopkins, Minn. Corporate Research Center.
MECHANISMS OF LASER-SURFACE INTERACTIONS Final Report
J. F. Ready, E. Bernal, and L. T. Shepherd May 1967 93 p refs
(Contract DA-18-001-AMC-1040(X))
(AD-654524) CFSTI: HC $3.00/MF $0.65

This report describes experimental and theoretical investigations of the particle emission produced in the laser-surface interaction. Preliminary measurements on the anguiar distribution of ions emitted from a tungsten target at power levels around 14 MW per sq. cm. indicate anisotropy of the emission, with a strong enhancement in directions near the normal to the target. Ion and neutral molecule emission from laser-irradiated sodium targets are described. Calculations on the free expansion of the laser-produced blow off material, which include the asymptotic velocity of the expansion, yield pulse shapes similar to those observed experimentally if a high initial temperature is assumed. The magnitudes and time histories of shock waves produced in the target by absorption of the laser radiation have been calculated. Author (TAB)

N67-35611# Corning Glass Works, N. Y.
GLASS LASER DAMAGE RESEARCH Final Technical Report, Jan. 1966–Jun. 30, 1967
R. D. Maurer, W. W. Lester, and M. E. Vance 30 Jun. 1967 95 p refs
(Contract N00014-66-C0159; ARPA Order 306; Proj. Defender)
(AD-654727)

The report covers an experimental investigation into the damage of glass by high intensity, 1.06 micron wavelength light pulses of millisecond duration. Damage due to optical absorption by impurities is demonstrated by ease of damage, above some intrinsic level, proportional to the measured optical absorption. An additional source of damage is optical absorption at 1.06 micron from the excited (fluorescing) state of the neodymium ion. Evidence for this mechanism is presented, and an approximate value of the excited state absorption cross section determined. The nonradiative decay (heating) back to the initial excited state is assumed to be the source of damage, and this appears reasonable from other data. Studies of opto-acoustic coupling are presented and their

connection with stimulated Brillouin scattering denoted. Measured coupling constants for different glasses, which are shown to be devoid of impurity optical absorption effects are presented. Stimulated Brillouin scattering as a cause of damage suggests correlation between these opto acoustic coupling constants and damage thresholds. Initial qualitative agreement between the two is encouraging enough to warrant further investigation of this technique as a way of predicting damage thresholds. Author (TAB)

N67-35619# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
INVESTIGATION OF STIMULATED RAMAN OSCILLATORS AND AMPLIFIERS Final Report
D. P. Borfeld, E. R. Peressini, and W. R. Sooy May 1967 85 p refs
(Contract DA-31-124-ARO(D)-202)
(P67-81; AROD-4408.5-P; AD-654429)

The results of an investigation of several non-linear optical effects are presented. Main emphasis is on the study of stimulated Raman scattering and mode selective techniques for giant pulse lasers. Secondary studies of optical harmonic generation and bleachable dye lasers are also discussed. It is shown that the gain in a diffusely pumped stimulated Raman scattering amplifier behaves according to the theory developed by Hellwarth and that the gain anomaly observed in colinear amplifiers (and explained as a consequence of beam trapping of the input beam) is, in fact, not present. A study of the mode selective properties of a passive Q-switch reveals that mode selection occurs as a result of the slow buildup of oscillation in a passive Q-switched laser. The character of spatial and temporal amplitude fluctuations in a laser beam is related to the degree of mode selection employed and the effect of these fluctuations on stimulated Raman conversion is given. A discussion is presented of laser action in two polymethene dyes in glycerol solution pumped by a giant pulse ruby. The potential for laser action in these particular dyes was identified in a parallel Hughes program. Author (TAB)

N67-35629*# Perkin-Elmer Corp., Norwalk, Conn.
DEVELOPMENT AND FABRICATION OF RING LASER SYSTEMS
P. H. Lee Dec. 1966 178 p
(Contract NAS8-11669)
(NASA-CR-88193; TR-8641) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The theory and operation of the ring laser rotation sensor is presented. The instrument and its component parts are described in detail. The laser embodies a complex optical resonator having controls for gain, nonreciprocal time delay, nonreciprocal transmission, and overall loss. The report also gives the system performance, conclusions, and recommendations. Author

N67-35660# Avco Corp., Wilmington, Mass. Space Systems Div.
A STUDY OF METHODS TO MEASURE THE EFFECTS OF A CONTAMINATED ATMOSPHERE ON THE TRANSMISSION OF A HIGH ENERGY LASER BEAM Final Report
Robert Schlier et al May 1967 153 p refs
(Contract DA-18-001-AMC-957(X))
(AVSSD-0183-67-RR; AD-654786) CFSTI: HC $3.00/MF $0.65

This report is concerned with the transmission of a high energy laser beam through an atmosphere containing aerosols. The experimental approach consists essentially in firing a high energy laser beam through an instrumented test chamber in which various known aerosols can be introduced. Various analyses are presented of the effects which may be expected, and experiments are described to demonstrate these effects. Breadboard experiments have been performed to verify certain experimental techniques and their description with some experimental results indicating a nonlinear interaction are included in this report. Finally, the specifications of an experimental test chamber in which laser beam experiments (at pressures up to 10 atmospheres) can be performed are included. Author (TAB)

N67-35662*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MODIFICATION OF THE GODDARD OPTICAL RESEARCH FACILITY Preliminary Engineering Report
Aug. 1967 29 p
(NASA-TM-X-55888; X-271-67-405) CSCL 14B

Building modifications to an optical research facility, which tracks and determines position of satellites with lasers, are cited. Construction of a field elevated laboratory for a program to determine the effects of atmospheric turbulence on coherent laser communication is discussed. Factors such as site selection, architecture, structure, plumbing, heating ventilation and air conditioning, and electrical systems are considered. Also included are a construction schedule, cost estimates, and drawings. S.P.

N67-35695# Princeton Univ., N. J. Frick Chemical Lab.
CHARGED PARTICLE EMISSION AFTER RUBY LASER IRRADIATION OF TRANSPARENT DIELECTRIC MATERIALS
W. E. Falconer (Bell Telephone Labs., Murray Hill, N. J.), D. L. Rousseau, and G. E. Leroi Jun. 1967 29 p refs
(Contract Nonr-1858(26))
(TR-7; AD-655105)

Ion currents induced by high power laser irradiation of transparent dielectric materials in vacuo below the threshold for physical damage have been investigated. Soft glass, Pyrex, fused quartz, Supracil quartz, CaF2, LiF, and sapphire all show similar behavior. Currents as large as 10 billion ions/pulse are obtained using ruby radiation with normal mode power levels of about 200 kW. Both positive and negative ion signals were studied, and for the latter case two distinct signals have been time resolved using Q-switched pulses. The emission is qualitatively similar to related investigations of laser irradiated metal surfaces. These effects are ascribed to laser heating of dust and other surface contaminants with subsequent production of high energy photons and thermionic emission of electrons and ions. The emission of photons, electrons and ions can be reduced, but not completely eliminated, by careful precleaning and repeated lasing on the dielectric surface. Author (TAB)

N67-35785# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
ARC DISCHARGE SOURCES Final Report, 16 Oct. 1964–28 Feb. 1967
Charles H. Church, B. W. Swanson, J. Lowke, R. Liebermann, P. Buchhave, et al 31 Mar. 1967 190 p refs
(Contract Nonr-4647(00); ARPA Order 306-62; Proj. Defender)
(RR-67-9C1-ARCSO-R1; AD-654718)

The report summarizes the studies towards the development of models for the highly radiative arcs used for the high energy pumping of lasers. The report also presents the experimental and theoretical studies since the last semiannual report. The experimental investigations were primarily concerned with more extensive measurements of the spectral radiance of the plasma to provide verification for the models. The theoretical work has resulted in computer methods, described in the appendices, to calculate the transport properties, the spectral absorptivities for the lines and the continuum of xenon, and the spectral radiance and temperature profiles in cylindrical arcs. Also included as an appendix is a theoretical analysis of the xenon arc using radiative transport techniques developed in other studies. Author (TAB)

N67-35927# Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
A QUANTUM STATISTICAL ANALYSIS OF A FREQUENCY MODULATED LASER COMMUNICATION SYSTEM
Neil F. Ruggieri 30 Apr. 1967 86 p refs
(Contract DA-31-124-ARO(D)-383)
(AROD-5659-3-E; AD-655119)

In this analysis the quantum statistics of the received signal of a frequency modulated laser communication system are derived. In particular the detection statistics for heterodyne and electric field detection of the frequency modulated laser beam are determined. These detection statistics are used to define a measure of the communication system performance in terms of a signal to noise ratio. The development of the quantum electromagnetic field in terms of the photon annihilation eigenstates is the basis for determining these statistics. The derivation used accounts for fluctuations in the carrier, fluctuations due to background radiation introduced after modulation, fluctuations due to the local laser oscillator, and zero point field fluctuations. The results of this analysis indicate the probability distribution for the optical heterodyne detection is not a familiar one of classical communication theory, but it is of the form of probability distribution that satisfies experimentally measured photocount statistics of unmodulated laser radiation. The probability distribution for the electric field intensity detection of the frequency modulated laser beam is the familiar Gaussian distribution. Author (TAB)

N67-36063# Royal Radar Establishment, Malvern (England). Ministry of Technology.
R.R.E. NEWSLETTER & RESEARCH REVIEW
Mar. 1967 93 p refs
(Rept.-6) CFSTI: HC $3.00/MF $0.65

Developments in crystal growth; infrared detectors; lasers; transistor structures; computer aided design of MOS integrated circuits; pulsed radars; ionospheric backscattering; and field effect transistors, are reviewed. Areas covered include: (1) the effect of electric fields on optical absorption edges, (2) anisotropy in the conduction band g-value for indium antimonide, (3) storage element alloy films, (4) thermal patterns over water, (5) improvements in photolithography, (6) glow discharge techniques for microelectronics, (7) aircraft responses due to very short pulses, and (8) the field dependence of the drift velocity in gallium arsenide. Other work activities are also reviewed. L.S.

N67-36330# Radio Corp. of America, Princeton, N. J.
THE RARE EARTH CHEMISTRY OF LASERS
P. N. Yocom *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 228–238 refs (See N67-36303 21-06)

Laser physics are discussed to show that the important quantities for obtaining laser action are the frequency of the transition, the fluorescent linewidth, the dipole moment matrix element of the transition, and the cavity properties. Both divalent and trivalent lanthanide ions can provide the needed properties. Crystal lasers are presented on the basis of the charge on the ion replaced by the lanthanide ion, including the properties and preparation of divalent lanthanide ions and the charge compensation of the trivalent ions in divalent sites. Sensitization in crystalline hosts and line broadening are discussed. The glasses containing lanthanide ions that show laser action are described and the effects of a glass matrix on the properties of the lanthanide ions are discussed. Rare earth chelate systems that show laser action and the inorganic, non-aqueous, liquid laser system are considered. Author

N67-36558*# General Telephone and Electronics Labs., Inc., Bayside, N. Y. Research Center.
INVESTIGATION OF ELECTRO-OPTICAL TECHNIQUES FOR CONTROLLING THE DIRECTION OF A LASER BEAM
J. Schlafer, A. J. Campillo, and V. J. Fowler 12 May 1967 80 p refs
(Contract NAS8-11459)
(NASA-CR-88115; TR-67-722.33) CSCL 20E

Two types of optical beam deflectors employing piezoelectrically driven mirrors have been investigated for application in optical acquisition and tracking systems. Operation of the shear-plate-mirror deflector at resonance for increased deflection has pointed up problems of depoling of the piezoelectric element at high strain levels. A new type of deflector, the piezoelectric bender driven mirror, has been developed for large aperture, high resolution applications requiring bandwidths up to a few kilohertz. To obtain more precise information on beam position in optical deflection systems, a number of deflection sensing schemes have been examined. By adapting digital techniques to the direct sensing of spot displacement, improved stability, resolution, and accuracy over analogue deflection sensing methods may be realized. A bender driven mirror deflector and digital deflection sensor have been combined in an optical system which can deflect through ± 1400 resolvable spots in two dimensions and measure beam position to within $\pm 1/4$ of a spot diameter. Author

N67-36578# Massachusetts Inst. of Tech., Cambridge.
LINCOLN LABORATORY
In its Res. in Mater. Sci. and Eng. Apr. 1967 p 375–398 refs
(See N67-36571 21-26)

Solid state theory and physics research at the Lincoln Laboratory is reported, along with applied physics investigations dealing with laser emission and electron beam excitation. Optics and infrared studies and electronic materials development are also summarized. M.W.R.

N67-36693*# Scientific Translation Service, La Canada, Calif.
TELEMETRY OF SATELLITES BY LASER AND ITS GEODESIC APPLICATIONS [LA TELEMETRIE DE SATELLITES PAR LASER ET SES APPLICATIONS GEODESIQUES]
R. Bivas Washington, NASA, Aug. 1967 13 p refs Transl. into ENGLISH from Rept. No. 121 of Centre Natl. de la Rech. Sci., Serv. d'Aeronomie (Verrieres-le-Buisson), May 1967 21 p Presented at the Intern. Meeting on Dyn. Methods of Geodesy by Means of Satellites, Paris, 22–25 May 1967
(Contract NASw-1496)
(NASA-TT-F-11192; Rept.-121) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The equipment installed in French and Greek satellite laser tracking stations is described. Results of experiments with the D1-C and D1-D satellites are given. Author

N67-36740# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SOLID STATE RESEARCH AT LINCOLN LABORATORY Quarterly Technical Summary Report, 1 Feb.–30 Apr. 1967
T. C. Harman et al 5 Jul. 1967 69 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-266; Rept.-2; AD-656548)

The report covers in detail the solid state research work at Lincoln Laboratory for the period 1 February through 30 April 1967. The topics covered are Solid State Device Research, Optical Techniques and Devices, Materials Research, and Physics of Solids. Author (TAB)

N67-36753# Air Force Cambridge Research Labs., Bedford, Mass. Optical Physics Lab.
A BIBLIOGRAPHY OF LASER APPLICATIONS
C. Martin Stickley and Arthur Gingrande Apr. 1967 46 p refs
Its Spec. Rept.-62
(AFCRL-67-0223; AD-655774)

The bibliography of laser applications contains 644 entries from the open literature for the period 1961 through September 1966. The entries are divided into the following major areas: mechanical measurements and standards; communications applications; radar and tracking applications; military applications; optical signal processing; interferometry and testing of optical components; applications to scientific studies; applications in chemistry; photographic applications; metalworking; and miscellaneous applications. The entries are further subdivided into 78 other categories. Applications in medical and biological research are not included; complete coverage in the other areas is not guaranteed. Under some topics (detection techniques, spectroscopy, interaction with acoustic waves, plasma diagnostics, nonlinear optics, gas breakdown, scattering, holography) so much has been published that only review articles, articles of major importance, and very recent articles could be included. Author (TAB)

N67-36773*# Stanford Univ., Calif. Microwave Lab.
INVESTIGATION OF COHERENT SOURCES OF INFRARED RADIATION Semiannual Status Report, Nov. 1, 1966–Apr. 30, 1967
A. L. Schawlow Jul. 1967 6 p refs
(Grant NGR-05-020-166)
(NASA-CR-88492; ML-1565; SASR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Cyanide lasers were investigated and found to be unsuitable for magnetic tuning. Preliminary studies of the pulsed laser anomalies are reported, including plasma refraction and absorption, plasma density, and an apparent small splitting of laser frequency. N.E.N.

N67-36786# United Kingdom Atomic Energy Authority, Culham (England). Research Group.
A FARADAY Q-SWITCH
J. E. Gruber, I. J. Spalding, and S. Ward Mar. 1967 16 p refs
(CLM-R-73) HMSO: 1s 9d

Electro- and magneto-optic Q-switches suitable for use with narrow line-width ruby lasers are briefly reviewed. Experiments on $\pi/2$ and $\pi/4$ Faraday-rotation Q-switches are described, and the operational convenience and merit of these switches is assessed. Author

N67-36790# Georgetown Univ., Washington, D. C. Dept. of Physics.
LIGHT DIFFRACTION BY ULTRASONIC SURFACE WAVES
Walter G. Mayer and Guillermo B. Lamers May 1967 29 p refs
(Contract Nonr-5037(01))
(TR-2; AD-655466)

The light intensity distribution in the orders of a diffraction pattern produced by the interaction of progressive ultrasonic surface waves and a monochromatic light beam is calculated. From the diffracted light intensity one can determine the amplitude of the surface wave, and from the spacing of the diffraction orders one obtains the velocity of the surface wave. Author (TAB)

N67-36824# American Science and Engineering, Inc., Cambridge, Mass.
INVESTIGATION OF THE VARIABLES CONTROLLING THE FLUX GROWTH OF HIGH QUALITY LASER CRYSTALS Final Report, 20 Aug. 1965–19 Aug. 1966
Carolus M. Cobb and Elbridge B. Wallis 27 Mar. 1967 140 p refs
(Contract AF 19(628)-5656)
(ASE-1572; AFCRL-67-0196; AD-655388)

A study was made of the solution variables, crystal constants, and system parameters which control the growth of large perfect crystals of refractory oxides from fused salt solvents. A set of formulas were developed for the prediction of growth conditions from these fluxes. Cooling rates, thermal gradients, stirring rates, and container dimensions were considered as system parameters. Solubilities, diffusion constants, viscosities, interfacial surface energies, solution and crystal densities, and solute radii were considered as independent variables. The formulas were applied to the prediction of crystal growing conditions for the production of sapphire and ruby from a lanthanum fluoride-aluminum oxide flux. The study included experimental determinations of the densities and viscosities of the lanthanum fluoride-aluminum oxide flux and experiments upon the solubility of aluminum oxide in this flux. Results from the program indicate that past and present difficulties with the fused salt technique of crystal growth have been caused primarily by hydrodynamic factors which may be overcome by detailed planning of experimental growth conditions. Author (TAB)

N67-36842*# Linde Div., Union Carbide Corp., Indianapolis, Ind.
DEVELOPMENT, FABRICATION, AND DELIVERY OF NEODYMIUM DOPED YAG LASER RODS Final Report, Mar. 19, 1965–Mar. 19, 1966
Howard M. Dess 19 Mar. 1966 45 p refs
(Contract NAS8-11865)
(NASA-CR-88510) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The melt pulling technique was scaled up and improved to permit the routine growth of high quality Nd:YAG crystals up to 0.65–0.75 inch in diameter by 3–3.5 inches long. Even in the largest of these specimens, the central core region can be maintained straight and narrow to permit fabrication of core-free 1/4-inch diameter laser rods. Annealing tests at 1850°–1870°C (approximately 100°C below the melting point of YAG) failed to eliminate the core. Similar tests on core-free Nd:YAG also failed to improve the quality as measured by passive optical tests. Fabricated were Nd:YAG laser rods with dielectric end coatings. These rods ranged from 3 mm to 6.38 mm in diameter and 30 mm to 75 mm in length. The rods cut from the largest diameter boules generally showed the best passive optical properties. This is attributed primarily to the more favorable growth conditions existing in the larger stations. The laser thresholds measured were greatly affected by the type of end configuration applied to the rod. No obvious correlation was found between the threshold values and the passive optical measurements recorded for the same rods. Author

N67-36866* International Business Machines Corp., Owego, N. Y. Electronics Systems Center.
STUDY PROGRAM TRANSMITTING INFORMATION BY OPTICAL ELECTRONICS (TIBOE) Final Report
[1964] 68 p refs
(Contract NAS10-2412)
(NASA-CR-88624; IBM-66-928-062) CSCL 09F

The requirements and detailed description of a laser system which can transmit information between a space vehicle and a launch platform by optical electronics are presented. The optical transmitters chosen for the demonstration are GaAs injection lasers operated without cooling. Pulse modulation schemes, including pulse-position (PPM), pulse-frequency (PFM) and PCM are utilized. Wide-beam transmitter and receiver optics are used to accommodate the large relative transverse motion expected between the vehicle and the Launch Umbilical Tower (LUT). Data curves and calculations for the performance of the system are given. L.S.

N67-37293# Technical Operations Research, Burlington, Mass.
LASER FOG DISDROMETER SYSTEM Final Report, 16 Sep. 1963–30 Apr. 1967
John Ward 30 Jun. 1967 68 p refs
(Contract AF 19(628)-3813)
(TO-B-67-32; AFCRL-67-0399; AD-656487)

Instrumentation to record and size naturally occurring fog droplets in the 5 microns to 100 microns diameter size range has been constructed and used in the field. The system is based on a two-step imaging technique using Fraunhofer holograms. A Q-switched ruby laser illuminates the sample volume and forms the holograms on aerial film. The short time pulse of the laser stops the motion of the droplets and provides instantaneous sampling periodically over the history of a fog. The Fraunhofer hologram technique allows both sufficient resolution as well as considerable depth of field to record the data. A readout instrument was also fabricated; this instrument counts and sizes the fog data by reconstructing, from the hologram frames recorded in the field, real images of the sample volume. Author (TAB)

N67-37455# United Aircraft Corp., East Hartford, Conn. Research Labs.
INVESTIGATION OF THE MECHANISMS ASSOCIATED WITH GAS BREAKDOWN UNDER INTENSE OPTICAL ILLUMINATION Semiannual Report, 1 Jan.–30 Jun. 1967
David C. Smith and Alan F. Haught Jun. 1967 35 p refs
(Contract Nonr-4696(00); ARPA Order 306)
(UACRL-F920272-10; AD-656084)

The work reported is part of a series of experimental and theoretical investigations of the mechanisms responsible for gas breakdown with focused optical frequency laser radiation. The effects of the mode structure of the laser radiation source on the gas breakdown threshold were studied. Experiments were also performed using a Mach-Zehnder interferometer to observe the breakdown plasma density and to determine the persistence and growth rate of the associated blast wave. The development of a high-power CO2 laser with an output at 10.6-micron wavelength was continued. TAB

N67-37501# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
PLASMA PRODUCTION BY A HIGH-POWER Q-SWITCHED LASER Quarterly Progress Report, 1 Feb.–30 Apr. 1967
A. G. Engelhardt 30 Apr. 1967 6 p
(Contract AT(30-1)-3472)
(WERL-3472-6; QPR-1) CFSTI: HC $3.00/MF $0.65

Development status of the gigawatt laser and its supporting equipment is given. Also, equipment for photon scattering experiments and microwave experiments is discussed. NSA

N67-37545# Materials Research Corp., Orangeburg, N. Y.
INVESTIGATION OF ELECTRON BEAM PROCESSING OF ALUMINUM OXIDE AND RELATED MATERIALS Final Scientific Report, 15 Nov. 1965–15 Nov. 1966
W. Class, H. R. Nesor, and G. T. Murray 15 Dec. 1966 110 p refs
(Contract AF 19(628)-4089)
(AFCRL-67-0273; AD-656769)

The report is concerned with the application of float-zone crystal growth techniques to refractory non-metallic materials currently of interest to the laser technology. Electron beam and hollow cathode discharge techniques were used to produce the molten zones. The electron beam technique yielded sapphire crystals having diameters up to 5/16 in. Dislocation densities of 100/sq cm were observed. Ruby crystals having similar diameters were also grown, but reveal a pronounced chromium coring because of the large chromium losses which occur in the electron beam environment. The hollow cathode technique yielded sapphire, ruby and yttrium aluminum garnet crystals. Both pure and doped garnet crystals were grown. Multiply doped garnets containing erbium and holmium were produced which do not contain the flawed core exhibited by Czochralski pulled crystals. Only a limited amount of work was done related to ruby growth because of feed rod preparation problems. Author (TAB)

N67-37615# Canadian Armament Research and Development Establishment, Valcartier (Quebec).
MASS DENSITY MEASUREMENTS IN HYPERSONIC WAKES
J. G. G. Dionne, C. M. Sadowski, L. Tardif, and J. E. H. Vanoverschelde *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 30 p refs (See N67-37601 22-12)
(ARPA Order 133)

Mean and fluctuating mass density measurements were made in hypersonic wakes over a wide range of ambient densities. An electron beam probe was found suitable at pressures of from 1–10 torr. The mass density was related to the fluorescent intensity resulting from the collisions between the highly energetic electrons and the wake molecules. At ambient pressures above 10 torr, mean mass densities were measured using a laser probe. The intensity of the Rayleigh scattered light measured at an angle of 90° to the incident beam was related in a simple way to the local wake density. Both methods were characterized by their capabilities of good spatial and temporal resolution. Measured mean radial density distributions at several downstream positions, as well as power spectra of the fluctuations are presented. The fluorescence spectra excited in air and nitrogen by electron bombardment at energies ranging from 25 to 75 kilo electron volt are discussed. Author

N67-37699*# National Aeronautics and Space Administration, Washington, D. C.
LASERS AND MASERS: A CONTINUING BIBLIOGRAPHY WITH INDEXES
Jul. 1967 447 p refs
(NASA-SP-7009(02)) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Abstracts and subject and author indexes are presented for research and development documents dealing with lasers and masers; with special emphasis on applications related to ranging and communication systems, astronomy and optics, and metal working. References are also included for fundamental studies dealing with the physical and electronic properties of lasers and masers and their function and performance. All of the references were previously announced in the NASA Scientific and Technical Aerospace Reports (STAR), International Aerospace Abstracts (IAA), or the NASA continuing bibliography on Aerospace Medicine and Biology; and the majority of the articles are arranged according to accession numbers in the first two of these sources. Both 1966 and 1967 entries are included for these as well as for a small group of LC entries from other journals. M.W.R.

N67-37715# European Space Research Inst., Frascati (Italy).
REPORT ON A STUDY GROUP ON LASER-PRODUCED PLASMAS
T. S. Green Paris, ESRO, Apr. 1967 12 p refs
(ESRO-SN-69) CFSTI: HC $3.00/MF $0.65

A small study group was held at ESRIN to discuss the production of plasmas by lasers and their application to plasma physics and spectroscopy with reference to the work of ESRIN. Delegates attended from several European laboratories. Discussions were divided into: (1) theory of plasma production using solids; (2) experimental observations using solid targets; (3) measurement techniques; (4) laser techniques; (5) gas breakdown and plasmas; (6) spectroscopic observations; and (7) application to ESRIN problems. Author (ESRO)

N67-37834# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Gas Ionizzati.
PLASMA DIAGNOSTICS BASED ON LASERS
U. Ascoli-Bartoli *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 487–496 refs (See N67-37816 22-25)

The aim of this note on plasma diagnostics based on the travelling of light through the plasma itself is to give some information about the possibilities offered by this kind of diagnostics.

The elementary phenomenon on which they are based is the Thompson scattering of a photon, caused by a free charge, in terms of which, as is well known, all macroscopic propagation phenomena (refractivity, diffraction and diffusion) can be described. Author (ESRO)

N67-37856# Electro-Optical Systems, Inc., Pasadena, Calif.
STUDY OF CROSS RELAXATION AND GLASS LASER AMPLIFIERS Final Report, 1 Nov. 1965–31 Jul. 1967
George L. Clark 31 Jul. 1967 41 p refs
(Contract N00014-66-C-0021; ARPA Order NRO15-627/9-7-65; Proj. Defender)
(EOS-7020-Final; AD-656763)

Spectral hole burning and cross-relaxation in neodymium-doped glass were investigated to determine whether stored energy can be removed rapidly by a spectrally narrow driving signal. By measuring the fluorescence from a pumped sample of glass before and after the passage of the signal pulse as a function of signal energy, quantitative estimates of cross-relaxation time and cross section for stimulated emission are made. Author (TAB)

N67-37903*# Autonetics, Anaheim, Calif.
OPTICAL BEAM STEERING DEVICE Final Report
18 Jan. 1967 25 p
(Contract NAS5-9688)
(NASA-CR-88869; C6-3203/401) CFSTI: HC $3.00/MF $0.65 CSCL 20E

This report describes an optical beam steering device (OBS). The device is intended to be used in conjunction with lasers as a means of changing the direction of the laser beam in a controlled manner by an electrical command signal. The concept employed for the OBS is based upon the use of piezoelectric bender bimorphs as the active deflection elements. Essentially all of the critical design requirements are met by the device. Author

N67-37921# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
EXACT VELOCITY MEASUREMENT BY MEANS OF A LASER INTERFEROMETER [MESURE PRECISE DES VITESSES AU MOYEN D'UN INTERFEROMETRE A LASER]
J. P. Taran 1967 10 p refs In FRENCH Presented at the Mesucora Congr., Paris, 17–21 Apr. 1967
(ONERA-TP-450/1967)

Experimental studies are detailed of velocity measurements by means of a laser interferometer. These highly coherent light sources are utilized in precision trajectography of moving objects. R.LI

N67-38030*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
SENSING OF METEOROLOGICAL VARIABLES BY LASER PROBE TECHNIQUES Semiannual Report, Feb. 1–Jul. 31, 1967
Giorgio Fiocco 30 Aug. 1967 13 p
(Grant NGR-22-009-131)
(NASA-CR-88872) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Laboratory experiments were conducted to determine the aerosol content of air from the spectral analysis of laser echoes. The laser beam was passed through an aperture to limit the amount of fluorescence radiation emitted, and then passed through a synchronized attenuator. The collected light was collimated and passed through a pressure-scanned Fabry–Perot interferometer. Measurements were made on the spectrum of light scattered from air in the laboratory containing natural aerosol particles, and on air containing an artificially produced dense fog. The analysis indicates that the dust-to-air ratio was approximately one. In another experiment, measurements were made of the density and temperature of the electrons in a low-density reflex discharge by scattering of continuous wave Ar^+ laser light. The data obtained were considered to be in good agreement with probe measurements. M.G.J.

N67-38093# Sperry Rand Research Center, Sudbury, Mass.
FLUORESCENT ION INTERACTION IN LASER CRYSTALS Semiannual Technical Summary Report, Period Ending 31 May 1967
William W. Holloway and Michael Kestigian 31 May 1967 37 p refs
(Contract N00014-67-C-0266; ARPA Order 306; Proj. Defender)
(SRRC-CR-67-35; AD-657250)

Factors influencing the fluorescence of the neodymium ion in garnet crystals (especially $Y_3Al_5O_{12}$) were investigated in order to improve the laser characteristics of these materials. In order to increase the doping levels of the active ions, the effect of compensating ions on the concentration of neodymium ions for given growth conditions was investigated. Possible deleterious effects in the optical properties of the active ion in the presence of these compensating ions were also studied. The use of energy transfer to enhance the fluorescence of the neodymium ion was considered. Energy transfer from the cerium ion to the neodymium ion was observed. In a collateral study, the optical properties of the cerium ion in garnet crystals were extensively investigated. Methods of improving the efficiency of the energy transfer in these materials were considered. TAB

N67-38721# United Aircraft Corp., East Hartford, Conn. Research Labs.
RESEARCH INVESTIGATION OF LASER LINE PROFILES Annual Technical Report, 1 Aug. 1966–31 Jul. 1967
Anthony J. De Maria, George L. Lamb, Jr., David A. Stetser, and Carl M. Ferrar 28 Aug. 1967 44 p refs
(Contract N00014-66-C-0344; ARPA Order 306; Proj. Defender)
(F-920479-4; AD-657210)

The objective of this program was to conduct experimental and theoretical investigations of laser line profiles. The broadened homogeneous line width of an argon ion laser was studied as a function of pressure and excitation by means of the Lamb Dip technique. Broadened homogeneous line widths of 200 to 400 MHz were recorded. These line widths are much larger than the 100 MHz radiative line width. The most plausible source for the boradened line is nonradiative phase interruptions occuring from small-angle Coulomb scattering in ion-ion collisions. It is shown that the line width decreases with increasing pressure for a certain range of laser oscillation. A simple collision broadening approach is not applicable to the ion system because of the behavior of the ion density as a function of pressure and excitation. Preliminary experiments were also performed with a CO_2-N2-He laser and no experimental indication of a Lamb Dip was found for this laser medium. Some aspects of the theory of a gas laser recently developed by W. E. Lamb, Jr. have been recast in a form which more fully displays the role played by the particle dynamics. It is shown that effects due to long range forces are most noticeable at long optical wavelengths and when there is a large difference between the lifetimes of the two-laser levels. Author (TAB)

N67-38866*# Radio Corp. of America, Princeton, N. J. Microwave Applied Research Lab.
DEVELOPMENT OF A 10.6-MICRON LASER MODULATOR Final Report, 18 Feb.–18 Jul. 1966
T. Walsh 18 Jul. 1966 23 p refs
(Contract NAS5-10144)
(NASA-CR-89267) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Electro-optic modulation, crystal growth and properties, and design equations and performance are reported for a 10.6-micron laser modulator of gallium arsenide. The constructed GaAs

modulator gives 61% depth of modulation for 1000 volts peak modulating signal over a bandwidth from dc to more than 20 MHz. Efficient and compact quarter wave plate and polarizers were developed for use at the 10.6-micron wavelength. The modulator was used to measure the electro-optic coefficient of GaAs over the 2.5 to 12 micron range by placing the GaAs crystal between parallel polarizers. A thick CdS wave plate, also placed between the polarizers, was oriented with its fast axis at 45° to the plane of passage of the polarizers. Phase retardation increased as the wavelengths became shorter. M.W.R

N67-39092*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

INTERCOMPARISON OF COLLOCATED LASER OPTICAL AND GRARR RADIO RANGING SYSTEM TRACKS ON GEOS-A

John H. Berbert, Paul Maresca (RCA Service Co.), Patrick Norris (RCA Service Co.), and Robert Reich (RCA Service Co.) Sep. 1967 38 p refs

(NASA-TM-X-55950; X-514-67-447) CFSTI: HC $3.00/MF $0.65 CSCL 17I

NASA is conducting a Geodetic Earth Orbiting Satellite-A (GEOS-A) Observation Systems Intercomparison Investigation. As part of this investigation, some tests consisted of side-by-side tracking of the GEOS-A spacecraft by the Goddard Range and Range Rate (GRARR) system and the Goddard Laser tracking system. Seventeen passes were observed from July to November 1966 by the Rosman, North Carolina GRARR station and 10 of these were evaluated. In the investigation, the Laser system tracks of the spacecraft were used as a reference trajectory for the GRARR system. The Laser data was smoothed using the GEOS-A Data Adjustment Program (GDAP) giving a reference orbit at the selected time of epoch in the form of a cartesian position and velocity vector. The evaluation of data shows that Laser orbits can be used to detect systematic errors in both range and range rate to about 2 meters and 1 centimeter per second respectively. Author

N67-39195# Sandia Corp., Albuquerque, N. Mex.

A MOBILE LASER TRANSCEIVER USED FOR DETECTING LONG RANGE, SLOW VELOCITY, AND LOW DENSITY TARGETS

M. J. Landry and J. R. Lochner Apr. 1967 21 p Presented at the 1st Intern. Conf. on Laser Appl. and World Exhibition of Instr. and Laser Tech., Paris

(Contract AT(29-1)-789)

(SC-DC-67-1596; CONF-670716-1) CFSTI: HC $3.00/MF $0.65

Two mobile laser transceivers to detect artificial clouds comprised of ablative materials from SNAP reentry vehicles for use in aerospace nuclear safety are described. The transceivers consist of ruby laser transmitters, mobile receivers, photomultiplier tube detectors, oscilloscope camera timing generators for recording, and power supplies. Atmospheric clouds were detected at a 26 mile range at night and at 43.2 mile range in daytime. NSA

N67-39353*# Varian Associates, Beverly, Mass. Quantum Electronics Div.

STUDY IMPROVEMENT OF THE HYDROGEN MASER Final Report, 30 Jul. 1965–31 Aug. 1966

R. F. C. Vessot, M. R. Baker, and M. W. Levine 18 Jan. 1967 40 p refs

(Contract NAS5-9888)

(NASA-CR-89275) CSCL 20E

Technical discussions are presented on components and techniques developed for greater ease of operation and maintenance and for field use. Details are given on the resistance-heated, water-cooled tungsten foil thermal dissociator. The hydrogen atom trajectories through magnetic fields of hexapolar symmetry are calculated. The automatic tuning system is analyzed and its components are described. Optimization of the bulb shape is discussed. N.E.N.

N67-39395# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

LASERS IN SPACE, ON THE EARTH, AND UNDER WATER

V. N. Chernyshev 26 Apr. 1967 92 p refs Transl. into ENGLISH of the publ. "Lazery V Kosmose, Na Zemle I Pod Vodoy" Moscow, Voyennoye Izd. Min. Oborony SSSR, 1964 p 1–104

(FTD-MT-65-373; TT-67-62867; AD-658382)

The working principles are considered of quantum-mechanical generators and amplifiers of optical range-lasers. Laser devices of different types and assignments are discussed. Laser radiation (abroad they are sometimes called death rays) can be used not only as a weapon of destruction, but also as a means of super-range communication, detection, and navigation. The pamphlet generalizes extensive but separated material published in domestic and foreign periodic press. The work is designed for readers with secondary education, familiar with the bases of radio engineering. Author (TAB)

N67-39408# Avco Corp., Wilmington, Mass. Space Systems Div.

LASER INDUCED SURFACE EFFECTS Final Technical Report

R. Schlier 10 Jul. 1967 40 p ref

(Contract DA-19-020-AMC-00521(X))

(AVSSD-0244-67-RR; AD-657600)

The document presents the results of experiments in which a moderate energy electron beam was used to probe the plasma created by a laser beam impinging on a graphite target. Author (TAB)

N67-39425# Johns Hopkins Univ., Balitmore, Md. Dept. of Physics.

LASER RAMAN SCATTERING STUDIES OF CRYSTALS Semiannual Progress Report, 16 Dec. 1966–15 Jun. 1967

Herman Z. Cummins 1 Aug. 1967 16 p refs

(Contract Nonr-4010(06); ARPA Order 306-63; Proj. Defender)

(AD-658342)

Temperature dependent Raman spectroscopy of quartz has revealed the existence of a new optical lattice vibration mode which appears to play a fundamental role in the alpha-beta phase transition. Continued temperature dependent Raman measurements of Strontium Titanate have also disclosed a new moving component in the spectrum. Additional measurements have also shown that the three sharp Raman lines which are present at all temperatures below the 110 degrees K cubic to tetragonal transition probably arise from local breaking of the translational symmetry by inhomogeneous strain within the domain walls. Intensity vs. temperature measurements of the strong component at 78 reciprocal cm (room temperature value) have failed to confirm our earlier conclusion that part of the room temperature Raman spectrum of Strontium Titanate is of first order. Preliminary Raman measurements have been performed on KDP, and have failed to produce conclusive evidence for an anticipated soft mode which was predicted by Cochran. TAB

N67-39452# Ballistic Research Labs., Aberdeen Proving Ground, Md.

OPTICAL METHOD FOR ANALYSIS OF ATMOSPHERIC EFFECTS ON LASER BEAMS

Paul H. Deitz Jul. 1967 46 p refs Presented at the Symp. on Mod. Optics, Sponsored by the Brooklyn Polytech. Inst., New York, 21–24 Mar. 1967

(BRL-MR-1840; AD-657559)

The report describes the design of an instrumentation system for the study of the effects of atmospheric turbulence on a collimated laser beam under near-earth conditions. The instrumentation consists of a helium-neon laser with optical collimator and a receiving system of 24-inch aperture with narrow bandpass filter. The Appendix presents examples of beam cross section patterns for different propagation conditions. The method of analyzing spatial intensity distributions of these patterns is described. Author (TAB)

N67-39460# Rochester Univ., N. Y. Dept. of Physics and Astronomy.
STATISTICAL PROPERTIES OF ELECTROMAGNETIC RADIATION Final Report, 1 Aug. 1964–31 Jul. 1967
Emil Wolf Aug. 1967 28 p refs
(Grant DA-ARO(D)-31-124-G-569)
(AROD-4965-28-P; AD-657586)

The research carried out was chiefly concerned with the following topics: Behavior of the electromagnetic field in the focal region of a coherent beam, coherence effects of second and higher orders, correlation techniques in classical and quantum optics, theory of photoelectric detection of light fluctuations, phase space distributions of fluctuating electromagnetic fields, fluctuations in laser beams, Thomson scattering in intense laser beams, and correlation effects in many ; .om radiation processes. Author (TAB)

N67-39527# Texas Univ., Austin. Plasma Dynamics Research Lab.
RESEARCH ON PLASMA DIAGNOSTIC METHODS FOR HIGH TEMPERATURE PLASMA RESEARCH Final Report, 1 Apr. 1965–31 Dec. 1966
Arwin A. Dougal, Otto M. Friedrich, Jr., M. O. Hagler, D. J. Mayhall, H. N. Roberts et al Wright-Patterson AFB, Ohio, ARL, Mar. 1967 121 p refs
(Contract AF 33(615)-3124)
(ARL-67-0062; AD-658052)

A new experimental arrangement of the infrared maser-interferometer detector combination employed to investigate dynamical gaseous plasmas and narrow, rapidly moving cylindrical detached shocks in a 30 kilojoule theta pinch was conceived, fabricated, and tested. This maser-interferometer-detector system has markedly improved frequency response. Because of its usefulness in determining the electron density from laser interferometry data, an expression for the laser resonator energy density as a function of the second resonator length was derived, under the assumption of dielectric mirrors. A Fabry-Perot interferometer in which the plane mirrors of infinite extent are prefaced by Brewster windows, and plane electromagnetic waves propagate along the z-axis through a lasing medium immersed in a steady state magnetic field was considered. The effect of the magnetic field on resonator tuning, on critical gain requirements, and on the polarization of the laser output beam were investigated. The advent of the giant pulse ruby laser as an extremely powerful energy source has provided the plasma researcher with a means of producing ultra-pure plasmas in which electron densities may range as high as 10 to the 21st power electrons/cc. A giant pulse ruby laser illuminated Mach-Zehnder interferometer is employed to study laser induced discharges in air at atmospheric pressure. Strong blast wave theory was employed to investigate the dynamics of gaseous plasmas produced when a giant pulse ruby laser was focused in gases initially at 1-2000 atmospheres. TAB

N67-39604# Martin Co., Orlando, Fla. Electromagnetics Lab.
COHERENT LIGHT TRANSMITTER Final Technical Report, Dec. 14, 1965–May 1, 1967
V. E. Derr Wright-Patterson AFB, Ohio, AF Avionics Lab., Sep. 1967 70 p refs
(Contract AF 33(615)-2022)
(AFAL-TR-67-213; AD-658858)

The nuclear-pumped laser could, in theory, provide a small, efficient source of coherent optical radiation capable of many years of untended operation. The main deterrent to its realization is existence of the laser cutoff effect: quenching of laser action by high energy radiation. An hypothesis based on electron-induced superradiance is in agreement with the experiment. A low threshold laser material, YAG:Cr-Nd, has been found to resist this effect up to doses of 960 rads. Author (TAB)

N67-39615# Cornell Univ., Ithaca, N. Y. Materials Science Center.
A STUDY OF PHOTON LOSS IN THE ACTIVE AND PASSIVE REGIONS OF A SEMICONDUCTOR LASER Interim Technical Report
Robert G. Hunsperger Jun. 1967 134 p refs
(Contract DA-31-124-ARO(D)-364)
(Rept.-675; AROD-5560-3-E; AD-658676)

Measurement and evaluation was made of the photon loss in the active and passive regions of a GaAs laser pumped by an electron beam. A theoretical expression was developed which gives the threshold current density required to produce lasing in an electron-beam-pumped laser when a portion of the length between Fabry-Perot surfaces was masked from the electron beam. This theoretical relation was experimentally verified by measurement of threshold current density as a function of masked length for numerous samples of GaAs at 4K. On the basis of these measurements the photon loss coefficients in the active and passive regions of the laser crystals were determined. The loss coefficients were found to be strongly dependent on impurity doping concentration. In addition the loss coefficient in the active region was observed to be less than the loss coefficient in passive material. This is attributed to an inhibiting of interband absorptive transitions by the inverted population in the active region. Author (TAB)

N67-39737# Hughes Research Labs., Malibu, Calif.
SELECTIVE ACCESS LASER DISPLAY BEAM POSITIONER Final Report, 1 Mar. 1966–30 Apr. 1967
James F. Lotspeich, James E. Kiefer, Wilbur P. Brown, Jr., and Neal H. Cosand Griffiss AFB, N. Y., RADC, Aug. 1967 118 p refs
(Contract AF 30(602)-4097)
(RADC-TR-67-381; AD-658840)

The experimental investigations and analytical studies indicate that controlled refractive deflection of laser beams by iterated electro-optic prism arrays of KD*P operated near the Curie temperature offers a promising approach to advancing the state of the art in high speed, selective access display applications. TAB

N67-39892*# Massachusetts Inst. of Tech., Cambridge.
SPECTROSCOPIC APPLICATIONS OF OPTICAL AND INFRARED MASERS Semiannual Status Report, Nov. 1, 1966–May 31, 1967
P. Schroeder et al 29 Sep. 1967 37 p refs
(Grant NGR-22-009-240, Proj. DSR-70382)
(NASA-CR-89632; SASR-1) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The technique for high resolution laser magnetospectroscopy has been developed using an amplitude stabilized infrared laser with He Ne and He Xe gas mixtures. The oscillatory interband magnetoreflection spectra have been obtained for single crystals of graphite, bismuth and arsenic, and pyrolitic graphite crystals. The Q-switching of CO_2 gas laser leads to a sudden decrease of population of the 001 level. Because of collisional coupling, the population of other nearby levels also change resulting in transient inversion of population at new transitions. The 4.3μ oscillation arising from this mechanism is now identified as 102→101. The ΔB for this transition is found to be $\pm 0.0031 \pm 0001$ cm^{-1}. The

preliminary results of detailed study of very high gain stimulated transitions in the $N_2(0, 0)$ band $C^3\Pi_u \rightarrow B^3\Pi_g$ are presented in this report. The narrow frequency bandwidth of these lines which is characteristic of the high gain is discussed. Finally, a brief description of the discharge requirements and inversion mechanism concludes the present experimental situation. Author

N67-39919# Texas Univ., Austin. Labs. for Electronics and Related Science Research.

ANALYSIS AND EVALUATION OF SIMPLE ELECTROMAGNETIC MODELS FOR LASERS IN AXIAL MAGNETIC FIELDS AND PLANE DIFFRACTION GRATINGS

Marion O. Hagler and Arwin A. Dougal 15 Aug. 1967 144 p refs

(Grant AF-AFOSR-766-67)

(AFOSR-67-1766 TR-35; AD-658018)

By using a vector Kirchoff integral and introducing suitable approximations for the electromagnetic fields on the surface of a plane diffraction grating, the fraction of the diffracted radiation appearing in each diffraction order is calculated here. The results are given as an explicit closed form function of the shape of the grooves on the grating surface and the wavelength of the incident radiation. On the basis of the analysis, it is shown that for a grating with triangular grooves which are wide and shallow compared to a wavelength of the incident radiation, the maximum amount of radiation is directed into a given diffraction order when the groove shape is such that the radiation is specularly reflected from one face. Finally, comparison with experimental data confirms the accuracy of the calculations in parameter ranges for which the simple model of the grating is expected to be valid. A simple electromagnetic model of a laser immersed in an axial magnetic field permits the polarization state of the emitted radiation to be described as a function of the single pass Faraday rotation angle and the anisotropy coefficient of the Brewster windows. It is shown that as the single pass Faraday rotation angle of the lasing medium is increased toward some critical value determined by the resonator anisotropies, the laser output fields are linearly polarized and the frequency remains constant. The output polarization angle increases to a maximum value psi sub o determined by the resonator anisotropies. Author (TAB)

N67-39984# Army Medical Research Lab., Fort Knox, Ky. Biophysics Div.

SURFACE TEMPERATURE AS A PARAMETER IN ESTIMATING LASER INJURY THRESHOLDS Interim Report

George R. Peacock 8 Jun. 1967 26 p refs

(AMRL-733; AD-658967)

A simple model based on elevation of the surface temperature in biological tissue was formulated in an attempt to aid in estimating laser injury thresholds. The model shows reasonable agreement in the ranges where experimental data are available. This fact lends confidence to predictions of injury thresholds for other laser wavelengths and pulse length. Predictions are made in particular for eye injury in the visible and near infrared, for tissue burns in the mid- and far-infrared. Author (TAB)

N67-40055# Johns Hopkins Univ., Baltimore, Md. Lab. of Astrophysics and Physical Meteorology.

ON THE PROPER USE OF LASER RADIATION IN THE CALIBRATION OF SPECTROMETER SCANNING FUNCTIONS Technical Report, 1 Jan. 1964–1 Nov. 1966

Louis Sica, Jr. 1 Jun. 1967 112 p refs

(Contracts Nonr-4010(14); AF 19(628)-4971; Grant CWB-10899)

(AD-654214)

Dependence of spectrometer scanning functions on the spatial coherence at the entrance slit implies that the spatial coherence of laser radiation must be degraded before its narrow spectral bandwidth can be used in scanning function calibration. Theoretical conditions on the necessary correlation function for "incoherent source" simulation are derived. Measurement of the correlation function at a slit in the case of an Hg source by the method of Beran and Parrent gives results which are in agreement with Hopkins' concept of an "effective source." Results using a laser-integrating sphere source indicate that it may be used interchangeably with an ordinary "incoherent" source for scanning function calibration. The problem of calculating the scanning function at any wavelength is discussed, and a common path interferometer which could be used to obtain the required output wavefront of a complete spectrometer is briefly described. It is shown that in the case of an Ebert spectrometer with a rectangular grating, some variation of the scanning function along the length of the circular slits is to be expected even in the case of perfect optics. Qualitative results of the use of a wave shearing interferometer in the measurement of the far field mutual intensity of a partially coherently illuminated slit are described. Author (TAB)

N67-40225# New York Univ., N. Y. Geophysical Sciences Lab.

OPTICAL SOUNDING III Final Report, 1 Apr. 1966–30 Mar. 1967

Richard M. Schotland, James Bradley, and Alan Nathan Ft. Monmouth, N. J., Army Electronics Labs., Jun. 1967 29 p refs

(Contract DA-28-034-AMC-02207(E))

(ECOM-02207-F; Rept.-67-2; AD-657601)

Studies have been conducted utilizing simulated data of a ruby laser radar to study atmospheric water vapor profiles. Transfer equations have been evaluated incorporating 20 water vapor lines near 6943A. It is shown that the 6943.815A line stands essentially isolated in the telluric spectrum. An analysis is presented of the uncertainties in the deduced water profile obtained for simulated data based upon the 6943.815A line. It is shown that for the present laser radar, the uncertainty in the deduced water vapor density originated primarily in the uncertainty associated with the water vapor absorption coefficient. The Doppler-broadening of radiation scattered from aerosol particles or by Rayleigh scattering processes does not obey the spectral density shape predicted from the Maxwell-Boltzmann distribution of velocities for the particles or air molecules. As Dicke has pointed out, spectral narrowing can occur due to collisions. This phenomenon is discussed in relation to the Doppler spectrum of scattered radiation. The conclusions have been confirmed in experiments reported in the literature. Author (TAB)

N67-40308# TRG, Inc., Melville, N. Y.

MULTI-MODE HIGH ENERGY LASER TRANSMITTER Interim Report, 6 Sep. 1966–15 May 1967

A. L. Pogoda and J. N. McGuire Aug. 1967 95 p

(Contract AF 33(615)-3888)

(IR-086-1; AD-658175)

The report outlines the progress made toward completion of the Multi-Mode High Energy Laser Transmitter System (MMHELTS) in the period from 6 September 1966 through 15 May 1967. In addition, it discusses design changes required for enhancement of the operation of the equipment in the field. Areas which TRG believe to be necessary additions and/or logical improvements to the operational capability of the overall system are discussed in detail. The overall configuration of the high energy system has not been changed from that in the design exhibit, submitted to Wright-Patterson Air Force Base on 1 September 1966. The ruby length of the Q-switched system, however, has been reduced to a total of 17 inches. The overall length has been divided into one Brewsters angled 4 in. Q-switched oscillator followed by 13 in. of active amplifier. The 13 in. amplifier section consists of a 4 in. cavity followed by a 9 in. cavity both of which are Brewsters angled. All ruby rods will remain 15mm in diameter. The status of the dynamic boresighting system development effort is also discussed herein. Author (TAB)

N67-40332# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati.

SOME CONSIDERATIONS ON THE POSSIBILITY OF OBTAINING A QUASI-MONOCHROMATIC POLARIZED PHOTON BEAM FROM LASER-ELECTRON SCATTERING IN THE STORAGE RING ADONE

R. Malvano, C. Mancini, and C. Schaerf 17 Jul. 1967 12 p *Its* Internal Note No. 372

(LNF-67/48) CFSTI: HC $3.00/MF $0.65

The possibility of using the electron beam of the Adone storage ring as a source of an intermediate energy quasi-monochromatic photon beam is discussed. The beam is obtained from the Compton scattering of coherent light from an argon gas laser on the high energy electrons circulating in the storage ring. Results of numerical computations on the interaction of a light photon and a fast moving electron are summarized. The duty cycle and polarization of the photon beam are briefly discussed and the energy spectrum of the background source is calculated. R.N.A.

N67-40361# Pennsylvania State Univ., University Park. Osmond Lab.

RESEARCH IN THE FIELD OF HIGH RESOLUTION INFRARED SPECTROSCOPY Final Report, 1 Nov. 1963–31 Oct. 1967

T. K. Mc Cubbin, Jr. Bedford, Mass., AFCRL, 31 Jan. 1967 70 p refs

(Contract AF 19(628)-3846)

(AFCRL-67-0437; AD-659042)

Infrared spectroscopic apparatus described in AD-602 493 was further developed and it was used to investigate the spectra of CO2 and N2O. A study of the infrared amplification of the helium neon laser was made and radiation from the N2-CO2 laser was used to measure the strengths and widths of absorption lines in the 10.6 micron band of CO2. The coherent and incoherent modes of laser illumination of a spectrometer were studied. Four reprints are included with the basic text: The 02(2)0-01(1)0 band of (14)N2(16)O, J. Optical Soc. Am. v54 p956 1964; Infrared vacuum grating-prism spectrometer, App. Optics v4 p711 1965; Determination of vibration-rotational line strengths widths in CO2 using a CO2-N2 laser, App. Phys. Letters v8 p118 1966; Study of helium-neon amplification at 3.39 microns, App. Optics v4 p1412 1965. TAB

N67-40539# Minnesota Univ., Minneapolis. Dept of Electrical Engineering.

THE EFFECT OF 3.39 MICRON SUPERRADIANCE ON THE 0.6328 MICRON OUTPUT POWER OF A HELIUM-NEON LASER

J. S. Hancock and J. A. Carruthers Aug 1967 35 p refs

(Contract DA-31-124 ARO(D)-402, ARPA Order 675)

(TR-1; AD-659005)

The effect of competition in a 0.6328 micron helium-neon laser from the high-gain 3.39 micron line has been studied. The 50 milliwatt laser used for the investigation employs a six-foot Brewster-angle tube and has a prism at one end to insure that oscillation occurs only at 0.6328 microns. Measurements were made of the 3.39 micron superradiance from one end of the tube when various calibrated reflectors were placed at the other end. With a typical dielectric coated mirror, designed for maximum reflectivity at 0.6328 microns, the superradiant 3.39 micron power from the other end of the tube was 75 microwatts. This result shows that in a 6 foot visible laser filled with a 10:1, He(3)-Ne mixture and employing a single prism for frequency selection, the 3.39 micron superradiance does not significantly affect the visible output power. However, the superradiance is about 2 orders of magnitude larger than estimated from theory, and presumably results mainly from multiple reflections from the tube walls. Author (TAB)

IAA ABSTRACTS

A67-20315
FERROELECTRIC EFFECT IN A LASER BEAM.
A. A. Chaban (Akademiia Nauk SSSR, Akusticheskii Institut, Moscow, USSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, Jan. 1, 1967, p. 20-23.)
JETP Letters, vol. 5, Jan. 1, 1967, p. 14-17. 7 refs. Translation.
Consideration of a piezoelectric crystal uniformly illuminated by a linearly polarized laser beam. It is shown that in very narrow self-focused beams in a nonpiezoelectric crystal the intensity of the time-constant electric field can exert an appreciable influence on the properties of the medium. F. R. L.

A67-20316
FREQUENCY DOUBLING OF LIGHT IN RUBY.
T. P. Belikova and E. A. Sviridenkov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, Jan. 1, 1967, p. 29-32.)
JETP Letters, vol. 5, Jan. 1, 1967, p. 22-24. 6 refs. Translation.
Consideration of possible causes of an observed double-frequency radiation in a crystal with an inversion center (ruby). The first may be magnetic-dipole and electric-quadrupole interaction between the laser light and the corundum lattice; the second may be the distortion of the corundum lattice by chromium ions; the third may be the anti-Stokes-Raman scattering of the laser light by the chromium ions. F. R. L.

A67-20372
EXTREMELY SMALL AND SIMPLE PULSE GENERATOR FOR INJECTION LASERS.
Walter Koechner (U.S. Army, Electronics Command, Fort Monmouth, N.J.).
Review of Scientific Instruments, vol. 38, Jan. 1967, p. 17-20.
A pulse generator is described for pulsing high power injection lasers at room temperature. The outstanding features of this pulser are the small size, cheapness, and simplicity, combined with the capability of switching several thousand amperes. However, the pulse repetition rate is limited to about 500 pulses/sec. The pulser may be used in optical systems where higher repetition rates are not necessary. Although this pulser was developed for pulsing injection lasers, it can also be used for all applications in need of high power pulses combined with the small size of the pulse generator. (Author)

A67-20413
A COMPARATIVE STUDY OF RECOMBINATION RADIATION FROM GaAs P-N JUNCTIONS WITH AND WITHOUT FABRY-PEROT RESONATORS.
T. N. Danilova, L. M. Kogan, S. S. Meskin, D. N. Nasledov, and B. V. Tsarenkov (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR).
(Fizika Tverdogo Tela, vol. 8, Aug. 1966, p. 2462-2465.)
Soviet Physics - Solid State, vol. 8, Feb. 1967, p. 1963-1965. Translation.

A67-20417
EXCITATION OF ULTRASONIC VIBRATIONS IN CRYSTALS UNDER THE ACTION OF RUBY LASER RADIATION.
A. N. Bondarenko, G. V. Krivoshchekov, S. I. Marennikov, E. V. Pestriakov, and G. A. Savvinykh (Akademiia Nauk SSSR, Sibirskoe Otdelenie, Institut Fiziki Poluprovodnikov, Novosibirsk, USSR).
(Fizika Tverdogo Tela, vol. 8, Aug. 1966, p. 2490-2492.)
Soviet Physics - Solid State, vol. 8, Feb. 1967, p. 1992, 1993. Translation.

A67-20418
GENERATION OF COHERENT RADIATION IN ELECTRON-HOLE PLASMAS IN INDIUM ANTIMONIDE.
A. P. Shotov, S. P. Grishechkina, and R. A. Muminov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Fizika Tverdogo Tela, vol. 8, Aug. 1966, p. 2496, 2497.)
Soviet Physics - Solid State, vol. 8, Feb. 1967, p. 1998, 1999. Translation.

A67-20595 #
LASER PHOTOGRAPHY AND SHADOWGRAPHS IN A FREE-FLIGHT RANGE.
D. J. Collins (General Motors Corp., GM Defense Research Laboratories, Flight Physics Laboratories, Santa Barbara, Calif.).
AIAA Journal, vol. 5, Mar. 1967, p. 605, 606.
Brief description of the final design and results of laser photography experiments. The equipment used obtains two perpendicular laser shadowgraphs simultaneously with a laser photograph of the model. A schematic of the experimental equipment is shown, together with three examples of laser photographs detailing the conditions of flight. A zigzag pattern visible on the model opens the possibility of measuring ablation rates by photographing the change in patterns originally layered on the free-flight model. A photograph in flight of a normal cone is shown. M. M.

A67-20672 *
A HIGH DATA RATE LASER COMMUNICATION SYSTEM.
C. V. Smith (Hughes Aircraft Co., Aerospace Group, Research and Development Div., Culver City, Calif.).
(Institute of Electrical and Electronics Engineers, Aerospace and Electronic Systems Convention, Washington, D.C., Oct. 3-5, 1966, Paper.)
IEEE Transactions on Aerospace and Electronic Systems, Supplement, vol. AES-2, Nov. 1966, p. 214-224.
Contract No. NAS 9-4266.
A sophisticated laser communication system has been built and tested both in the laboratory and over field distances. It is envisioned that laser systems using the same techniques might someday return real time television and telemetry from manned interplanetary spacecraft. In the breadboard system, commercial rate television, sound, and a data channel are multiplexed into a 30 x 100 bit/sec (PCM) format, and this signal is modulated onto the laser beam using polarization modulation (PL). We believe this is the first application of a high-power argon ion laser in a communication system. The paper contains an illustrated description of the system, a brief discussion of problems associated with the integration of the high power laser and the wide band modulator, and a summary of experimental results obtained under field conditions. Photographs of the TV monitor, transmitted under various atmospheric conditions, are included. (Author)

A67-20683
NANOSECOND LASER IMAGING.
John N. Packard (Aircraft Armaments, Inc., Cockeysville, Md.).
(Institute of Electrical and Electronics Engineers, Aerospace and Electronic Systems Convention, Washington, D.C., Oct. 3-5, 1966, Paper.)
IEEE Transactions on Aerospace and Electronic Systems, Supplement, vol. AES-2, Nov. 1966, p. 329-332.
Selective imaging of objects in range is demonstrated using a giant pulse ruby laser illuminator synchronized with a high speed Kerr cell camera. Elimination of film exposure due to backscatter in a turbid atmosphere is accomplished. Analytic expressions for

film exposure due to gated target returns and backscatter luminance are derived. Data obtained for exposures over a 300-m clear atmospheric path and a 30-m turbid atmospheric path, $\alpha \approx 6.7 \times 10^{-2}$ per meter, agree with predicted results. The technique is a useful operational mode for short range pulsed laser imaging systems under adverse seeing conditions. (Author)

A67-20687
AN OPTICAL RANGE-GATED FILTERING TECHNIQUE FOR MTI RADAR.
S. Levinson (Honeywell, Inc., Radiation Center, Boston, Mass.), B. J. Pernick, and D. Yustein (Grumman Aircraft Engineering Corp., Bethpage, N.Y.).
(Institute of Electrical and Electronics Engineers, Aerospace and Electronic Systems Convention, Washington, D.C., Oct. 3-5, 1966, Paper.)
IEEE Transactions on Aerospace and Electronic Systems, Supplement, vol. AES-2, Nov. 1966, p. 378-384.
Research sponsored by the Grumman Advanced Development Program.

Description of an optical range-gated filter for detecting moving targets in a clutter background. The proposed filter is an analog computer in which x and y position coordinates represent, respectively, range and time in the input plane, and range and frequency in the output plane. The input echoes are illuminated with a coherent beam of light. The echoes modify the coherent light beam, which is then integrated either by a lens, or by an equivalent process, in the far field of the diffraction pattern of the input transparency. The experimental setup of this filter is described, and test results and theoretical calculations are cited. A.B.K.

A67-20691
PERFORMANCE OF A TRAVELING WAVE MASER FOR MONOPULSE RADARS.
Simpson B. Adler (Radio Corporation of America, Moorestown, N.J.).
(Institute of Electrical and Electronics Engineers, Aerospace and Electronic Systems Convention, Washington, D.C., Oct. 3-5, 1966, Paper.)
IEEE Transactions on Aerospace and Electronic Systems, Supplement, vol. AES-2, Nov. 1966, p. 408-413.
Navy-supported research.

Results of theoretical and experimental work on the performance of a C-band traveling-wave maser for monopulse radar applications. It is shown that under a saturating pulse the maser gain drops exponentially with time and is dependent mainly on the power level and duration of the applied signal. In general, it is found that the maser begins to saturate at input levels between -30 dbm and -10 dbm. Recovery from saturation is also found to occur exponentially with time and to be governed mainly by the spin-lattice relaxation time, which is about 5 msec. A description is given of a novel technique for duplexing the maser, so as to reduce by 70 db the requirement for isolating the maser from high-power transmitters. Relative phase stability is measured to be about 3° peak-to-peak and relative amplitude stability about 0.5 db peak-to-peak over several minutes, under pulse conditions. A.B.K.

A67-20769 #
THEORETICAL AND EXPERIMENTAL ANALYSIS OF THE PRESENT POSSIBILITIES OF USING LASERS FOR TELEPHONE CIRCUITS [ANALISI TEORICA E SPERIMENTALE DELLE ATTUALI POSSIBILITÀ DI UTILIZZARE IL LASER NEI COLLEGAMENTI TELEFONICI].
G. Tamburelli.
Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 14th, Genoa, Italy, Oct. 12-15, 1966, Paper. 37 p. 6 refs. In Italian.

Investigation of the possibilities offered by a laser in the implementation of laser-telephone circuits (similar to radio circuits). Two experimental telephone circuits were implemented over a distance of 900 m and 5600 m, in order to gather experimental data necessary for determining the components and characteristics of a laser-telephone hookup. The results obtained indicate that the use of a laser beam with a wavelength of 6328 Å must be restricted to countries free of fog, where the visibility is not lower than 2 to 3 km. M.M.

A67-20823
INDUCED RADIATION FOR LARGE PHOTON DENSITIES.
B. I. Bondarev.
(Radiofizika, vol. 8, no. 6, 1965, p. 1155-1159.)
Soviet Radiophysics, vol. 8, Nov.-Dec. 1965, p. 834-837. 5 refs. Translation.

A67-20839
ENERGY BALANCE OF THE RADIATION NOISE IN LASERS.
B. I. Stepanov and A. S. Rubanov (Akademiia Nauk Belorusskoi SSR, Institut Fiziki, Minsk, Belorussian SSR).
(Akademiia Nauk SSSR, Doklady, vol. 169, Aug. 1, 1966, p. 819-822.)
Soviet Physics - Doklady, vol. 11, Feb. 1967, p. 700-702. Translation.

A67-20840
DAMAGE PRODUCED BY A LASER BEAM IN A TRANSPARENT DIELECTRIC.
B. M. Ashkinadze, V. I. Vladimirov, V. A. Likhachev, S. M. Ryvkin, V. M. Salmanov, and I. D. Iaroshetskii (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR).
(Akademiia Nauk SSSR, Doklady, vol. 169, Aug. 11, 1966, p. 1041-1043.)
Soviet Physics - Doklady, vol. 11, Feb. 1967, p. 703-705. Translation.

A67-20856
EFFECT OF POWERFUL LIGHT FLUXES ON METALS.
S. I. Anisimov, A. M. Bonch-Bruevich, M. A. El'iashevich, Ia. A. Imas, N. A. Pavlenko, and G. S. Romanov.
(Zhurnal Tekhnicheskoi Fiziki, vol. 36, July 1966, p. 1273-1284.)
Soviet Physics - Technical Physics, vol. 11, Jan. 1967, p. 945-952. 9 refs. Translation.

A67-20868 #
FREQUENCY BROADENING OF THE NATURAL OSCILLATIONS OF A RESONATOR DUE TO AN INTERACTION WITH AN ATOM [FREQUENZVERBREITERUNG EINER RESONATOREIGENSCHWINGUNG DURCH WECHSELWIRKUNG MIT EINEM ATOM].
G. Richter (Deutsche Akademie der Wissenschaften, Institut für spezielle Probleme der theoretischen Physik, Berlin, East Germany).
(Tagung über Laser und ihre Anwendungen, Berlin, Germany, Nov. 8-11, 1966, Vortrag.)
Annalen der Physik, vol. 18, no. 7-8, 1966, p. 331-352. 15 refs. In German.

Study of the frequency broadening of the natural oscillations of a resonator upon interaction with a two-level atom. It is shown that such an interaction leads to a symmetrical splitting of the unperturbed resonance frequency into two frequency pairs with sharply differing linear separations. The inner frequency pair is shown to correspond to a tuning of the natural frequency of the resonator by the introduced anharmonic atom. Its frequency separation is found to decrease with increasing field amplitude and to vanish in the limiting case of a very large number of light quanta. The outer frequency pair is shown to be determined by the frequency of absorption and re-emission of a light quantum by the atom and is related to a weak amplitude modulation of the resonator oscillation. The frequency difference of this pair is found to increase linearly with field amplitude. A.B.K.

A67-20989
INTERSTELLAR VEHICLE PROPELLED BY TERRESTRIAL LASER BEAM.
J. L. Redding (Bishop's University, Lennoxville, Quebec, Canada).
Nature, vol. 213, Feb. 11, 1967, p. 588, 589.

Criticism of Marx's model of interstellar travel in a vehicle driven by the pressure exerted on it by a light beam transmitted from the earth. It is pointed out that Marx's equations for the momentum and energy gained in a time δt by the mirror reflecting the light wave are improperly constructed and therefore incorrect. The correct equations for the momentum and energy gains are then given, and it is shown that the "instantaneous mechanical efficiency" does not rise to 100%, as claimed by Marx, but has a maximum value of 34%. The reason for this decrease in efficiency is found to reside in the fact that the intensity of the radiation measured in the rest frame of the vehicle decreases as the velocity increases. A.B.K.

A67-21142
LASER INTERFEROMETRY AS A MEASURE OF TURBULENT FLUCTUATIONS.
H. Guthart and W. E. Scharfman (Stanford Research Institute, Electromagnetic Sciences Laboratory, Menlo Park, Calif.).
Physics of Fluids, vol. 9, Dec. 1966, p. 2525-2527. 6 refs.
ARPA-supported research.

The power spectral density of the integrated neutral particle density fluctuations in the turbulent exhaust of a sonic jet has been measured using a laser interferometer. The measurements are compared with calculations of the power spectral density function. (Author)

A67-21203 #
FIBER LASER WITHOUT A RESONATOR [BEZREZONATORNYI VOLOKONNYI LAZER].
Kh. I. Gaprindashvili, V. V. Mumladze, G. G. Mshvelidze, M. E. Perel'man, and V. A. Khanevichev (Akademiia Nauk Gruzinskoi SSR, Institut Kibernetiki, Tiflis, Georgian SSR).
Akademiia Nauk Gruzinskoi SSR, Soobshcheniia, vol. 45, Jan. 1967, p. 57-64. 14 refs. In Russian.

Theoretical and experimental investigation aimed at obtaining stimulated radiation from Nd^{+3}-doped barium crown glass fibers, without employing resonators. The procedure used in the preparation of the fibers is described, together with some preliminary results obtained with this type of laser. The theoretical aspects of obtaining stimulated radiation without the aid of resonators are examined. V.P.

A67-21204 #
CANCELLATION OF A LASER BY A LASER [GASHENIE LAZERA LAZEROM].
V. P. Berezovskii, R. N. Kukharskii, and V. V. Mumladze (Akademiia Nauk Gruzinskoi SSR, Institut Kibernetiki, Tiflis, Georgian SSR).
Akademiia Nauk Gruzinskoi SSR, Soobshcheniia, vol. 45, Jan. 1967, p. 65-68. In Russian.

Experimental investigation showing that irradiation of a ruby laser by a similar laser situated at a right angle to the first results in a reduction in radiation intensity of the irradiated laser. The effect becomes appreciable when the irradiating laser operates above the pumping threshold. V.P.

A67-21222 *
A POSITIVE RESISTANCE UP-CONVERTER FOR ULTRA-LOW-NOISE AMPLIFICATION.
E. Sard, B. Peyton (Cutler-Hammer, Inc., Airborne Instruments Laboratory Div., Applied Electronics Dept., Melville, N.Y.), and S. Okwit (Cutler-Hammer, Inc., Airborne Instruments Laboratory Div., Electrophysics Dept., Melville, N.Y.).
IEEE Transactions on Microwave Theory and Techniques, vol. MTT-14, Dec. 1966, p. 608-618. 6 refs.
NASA-supported research.

An ultralow-noise two-channel tunable amplifier system, operating in the 1.5 to 2.5 GHz frequency range, consisting of a cooled positive resistance parametric up-converter followed by a traveling-wave maser (TWM) and down-converter, has been developed. A theoretical analysis of the important operating and design parameters of the up-converter is presented and experimentally verified. Experimental data is given on the operation of the up-converter with the input and output ports reversed (down-converter), and is shown to correlate with the theoretical model. A brief discussion is presented on the TWM, and the spurious signal considerations which govern the choice of maser center frequency (up-converter output frequency). Finally, some preliminary system data is given showing the low noise performance of the overall cascaded amplifier integrated with a $4.2^{\circ}K$ closed-cycle refrigerator. (Author)

A67-21269
RELATED PROBLEMS IN THE DEVELOPMENT OF LASER AND MICROWAVE ENGINEERING.
I. V. Lebedev.
(Radiotekhnika /Kiev/, vol. 8, Nov.-Dec. 1965, p. 625-631.)
Soviet Radio Engineering, vol. 8, Nov.-Dec. 1965, p. 468-471.
17 refs. Translation.

A67-21270
THE EFFECT OF LOAD MISMATCH ON THE OPERATION OF A LASER.
V. V. Lebedeva, I. V. Lebedev, and A. I. Odintsov.
(Radiotekhnika /Kiev/, vol. 8, Nov.-Dec. 1965, p. 632-636.)
Soviet Radio Engineering, vol. 8, Nov.-Dec. 1965, p. 472-474.
Translation.

A67-21283
LASERS - HOW FAR ALONG?
James Baum (Electro-Optical Systems, Inc., Pasadena, Calif.).
Space/Aeronautics, vol. 46, Dec. 1966, p. 97-104.

Discussion of the developments in laser technology, from the ruby laser to the CO_2 laser and the semiconductor laser. Various modern laser applications are examined, and the position occupied by the laser with respect to other competing technologies in the fields of communications, ground-to-ground and air-to-ground fire control, ground radar, night reconnaissance, and high-speed data processing is outlined. V.P.

A67-21289
OPTICAL AND ELECTRICAL PROPERTIES OF EPITAXIAL AND DIFFUSED GaAs INJECTION LASERS.
M. H. Pilkuhn and H. Rupprecht (International Business Machines Corp., Thomas J. Watson Research Center, Yorktown Heights, N.Y.).
Journal of Applied Physics, vol. 38, Jan. 1967, p. 5-10. 13 refs.
ARPA-Navy-DOD-Army-supported research.

GaAs injection lasers were prepared by an epitaxial solution growth method and their properties compared with those of diffused junctions. The optical gain factor β was up to a factor of 7 higher for the epitaxial diodes at $300^{\circ}K$. This result in threshold current densities as low as 26,000 amp/cm^2 (3.8×10^{-3} cm length) at $300^{\circ}K$. At $77^{\circ}K$, gain factor and loss numbers were similar for the two laser types. The spontaneous linewidth of the epitaxial lasers was unusually large (~ 300 Å at $77^{\circ}K$) and increased with decreasing junction voltage. The internal quantum efficiency of epitaxial diodes drops from 100% at $4.2^{\circ}K$ to 40% at $300^{\circ}K$. The vertical beam spread was found to be between 20°-30° half-width at $77^{\circ}K$ as well as at $300^{\circ}K$. Diffused diodes frequently show a delay between the current pulse and the stimulated emission of up to 30 nsec, dependent on the current value at higher temperatures. No such delay was observed in epitaxial lasers. (Author)

A67-21306 *
EFFECTS OF LASERING UPON THE ELECTRON GAS AND EXCITED-STATE POPULATIONS IN XENON DISCHARGES.

R. J. Freiberg and L. A. Weaver (Illinois, University, Gaseous Electronics Laboratory, Urbana, Ill.).
Journal of Applied Physics, vol. 38, Jan. 1967, p. 250-262. 36 refs. NASA-sponsored research.

Spatially resolved electron density measurements are reported for dc-excited xenon laser discharges over a pressure range of 12.5 to 25.5 mtorr. Due to electrophoretic effects within the closed capillary tube, anode-directed gradients in electron density are established which affect local population inversions. The influence of lasing upon these discharges is investigated experimentally by using a 3.51-μ ($5d_{33}$-$6p_{22}$) laser whose optical cavity Q is periodically spoiled by a mechanical chopping wheel. It is observed that lasing noticeably alters the state of the electron gas and the populations of excited xenon atoms. The discharge current is decreased due to lasering by up to 0.02%, and spatially resolved microwave cavity measurements reveal that lasing may either increase or decrease the electron density by approximately 10^9 cm^{-3} depending upon local discharge conditions. Laser-induced changes in the microwave cavity Q and the electron drift velocity indicate that lasing also affects the mean electron energy. Ionization via electron impact from the upper laser level and the xenon metastables is suggested as the dominant physical process responsible. Radiative and collisional mechanisms responsible for the propagation of the laser-induced perturbation from the $5d_{33}$ and $6p_{22}$ levels to other excited levels are discussed. It is suggested that laser media in general can be analyzed and improved upon by studying the laser-induced changes in excitation and relaxation processes. (Author)

A67-21309
PHASE-LOCKING OF LASER OSCILLATORS BY INJECTED SIGNAL.
C. L. Tang (Cornell University, School of Electrical Engineering, Ithaca, N.Y.) and H. Statz (Raytheon Co., Research Div., Waltham, Mass.).
Journal of Applied Physics, vol. 38, Jan. 1967, p. 323, 324. 7 refs. USAF-supported research.

The condition for frequency locking of a laser oscillator by an externally injected signal is derived. The results allow one to estimate the minimum-frequency separation in rotation sensing ring lasers as a function of scattering in the beam path. The formula may also be used as a design criterion in phase-locking arrays of laser oscillators. (Author)

A67-21310
GAS DESORPTION PRODUCED BY A GIANT PULSE LASER.
L. P. Levine, J. F. Ready, and E. Bernal G. (Honeywell, Inc., Research Center, Hopkins, Minn.).
Journal of Applied Physics, vol. 38, Jan. 1967, p. 331-336. 8 refs. Army-supported research.

The gases desorbed when a tungsten target in a vacuum of the order of 10^{-8} torr is struck by a Q-switched laser beam are studied. The apparatus used in the experiment is described. The data presented are for water vapor, carbon monoxide, and carbon dioxide. Analysis is presented to demonstrate that the data are compatible with a model in which the laser is considered to be no more than a pulsed heat source for laser energy densities up to 50 mw/cm^2. (Author)

A67-21314
POLARIZATION AND MODE HOPPING IN A GAS LASER.
N. R. Isenor (Waterloo, University, Dept. of Physics, Waterloo, Ontario, Canada).
Journal of Applied Physics, vol. 38, Jan. 1967, p. 417, 418. 5 refs. Research supported by the National Research Council of Canada.

Study of longitudinal mode oscillations of an internal-mirror gas laser when the length of the resonator is changed smoothly with time. It is shown that as the cavity length is swept, a new longitudinal mode oscillation may begin to grow with a polarization orthogonal to that of the existing oscillation and suddenly flip to a more favored polarization with an abrupt increase in amplitude. In these instances, the original oscillation performs a polarization and amplitude change exactly complementary to that of the new oscillation. A.B.K.

A67-21375
A QUANTITATIVE STUDY OF THE STIMULATED RAMAN EFFECT USING AN OFF-AXIS RESONATOR.
N. V. Karlov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR), R. H. Pantell (Stanford University, Stanford, Calif.), B. G. Huth, and H. E. Puthoff.
IEEE Journal of Quantum Electronics, vol. QE-2, Dec. 1966, p. 763-769. 23 refs.
Contract No. Nonr-225(48).

The use of an off-axis resonator system to study the generation of first-Stokes radiation in benzene is considered both theoretically and experimentally. The primary advantage of the off-axis system concerns the fact that the resonator is driven by a temporal and spatial average of the exciting laser beam, thereby minimizing light trapping effects. With these trapping effects reduced in relative importance, quantitative measurements of the stimulated Raman effect in self-focusing materials are possible, and the experimental data agree with the steady-state solution presented here to within the experimental accuracy. (Author)

A67-21376
EXCITATION CROSS SECTION OF SOME OF THE STATES OF Ne II, Ar II, AND Kr II BY ELECTRON COLLISION.
S. H. Koozekanani (Ohio State University, Dept. of Electrical Engineering, Antenna Laboratory, Columbus, Ohio).
IEEE Journal of Quantum Electronics, vol. QE-2, Dec. 1966, p. 770-773. 13 refs.

Use of the sudden-perturbation method to calculate the excitation cross section of some of the states of Ne II, Ar II, and Kr II by high-energy electrons. In this method, the ground state of the noble gas atom, after a collision with a fast electron, is considered to lose one of its valence electrons in a time shorter than the relaxation time of the atom. Since no experimental measurements for the excitation cross sections with fast electrons are given, the results of the calculations are indirectly compared with the available work reported on the pulsed Ar II laser. Population of various excited ionic states is calculated assuming a uniform energy distribution of electrons having 1.8 times the ionization threshold of argon, and the results are compared with experimental data reported in the literature. M.F.

A67-21377
EFFECT OF GAIN SATURATION ON THE OSCILLATING MODES OF OPTICAL MASERS.
A. G. Fox (Bell Telephone Laboratories, Inc., Crawford Hill Laboratory, Coherent Wave Physics Dept., Holmdel, N.J.) and Tingye Li (Bell Telephone Laboratories, Inc., Crawford Hill Laboratory, Holmdel, N.J.).
IEEE Journal of Quantum Electronics, vol. QE-2, Dec. 1966, p. 774-783. 21 refs.

Results of a computer study of modes having circularly symmetric intensity distributions for both Fabry-Pérot and confocal resonators with circular mirrors immersed in a uniformly pumped saturable-gain medium with uniform dielectric constant. The cardinal features of active modes, such as mode patterns, diffraction losses, and resonant frequencies, were found to be essentially the same as those of the passive modes, even for unsaturated gains as high as 3-1/2 db per pass. The mode that predominates in an active Fabry-Pérot resonator is found to be the lowest-order (TEM_{00}) mode. However, the predominating modes in an active confocal resonator are found to depend on the Fresnel number; the larger the Fresnel number, the higher is the mode order. The study includes computations of field distributions, diffraction losses, and phase shifts of the steady-state predominating modes and of their output intensities as functions of unsaturated gain, saturation parameter, mirror transmissivity, scattering loss, and resonator geometry. M.F.

A67-21378
A PHASE COMPARISON OPTICAL DISCRIMINATOR.
P. H. Lee and M. L. Skolnick (Perkin-Elmer Corp., Norwalk, Conn.).
IEEE Journal of Quantum Electronics, vol. QE-2, Dec. 1966, p. 784, 785.

Description of a new method for generating the error signal needed to control the laser frequency of a laser oscillator. The technique employed is an optical analog of the ac Pound Stabilizer often used to improve the frequency stability of tunable microwave sources. M. F.

A67-21379
LASER TRANSITIONS IN B II, Br II, AND Sn.
H. G. Cooper and P. K. Cheo (Bell Telephone Laboratories, Inc., Whippany, N.J.).
IEEE Journal of Quantum Electronics, vol. QE-2, Dec. 1966, p. 785.

Study of three laser oscillations from B II, Br II, and Sn in pulsed discharges of BCl_3, HBr, and $SnCl_4$, respectively. The three transitions, with identification for B II and Br II obtained from Moore, are tabulated. The lowest values of peak pulse current used to obtain laser action from Sn and B II or Br II are on the order of 30 and 50 amp, respectively. M. F.

A67-21434 #
MEANS, VARIANCES, AND COVARIANCES FOR LASER BEAM PROPAGATION THROUGH A RANDOM MEDIUM.
Robert A. Schmeltzer (North American Aviation, Inc., Autonetics Div., Electro-Optical Laboratory, Anaheim, Calif.).
Quarterly of Applied Mathematics, vol. 24, Jan. 1967, p. 339-354. 5 refs.

Wave propagation in a random continuous medium is studied by solving the stochastic wave equation with a random function for the refractive index coefficient. By the application of the Rytov transformation, an equivalent spatial form of the nonlinear Riccati equation is obtained which is then solved by means of an iteration scheme. The statistical properties of the propagated wave are then computed for the case of a coherent focused source with a Gaussian amplitude distribution. These formulas contain , as limiting subcases, the results of previous analyses for the spherical and plane wave. More generally, they describe the propagation of a laser beam. (Author)

A67-21448
SOME PROPERTIES OF SEMICONDUCTOR LASERS BASED ON INDIUM PHOSPHIDE.
N. G. Basov, P. G. Eliseev, I. Ismailov, A. Ia. Nashel'skii, I. Z. Pinsker, and S. V. Iakobson (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Fizika Tverdogo Tela, vol. 8, Sept. 1966, p. 2610-2615.)
Soviet Physics - Solid State, vol. 8, Mar. 1967, p. 2087-2091. 12 refs. Translation.

A67-21449
PROPERTIES OF DIODE QUANTUM GENERATORS PREPARED FROM GALLIUM ARSENIDE.
N. G. Basov, P. G. Eliseev, S. D. Zakharov, Iu. P. Zakharov, I. N. Oraevskii, I. Z. Pinsker, and V. P. Strakhov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Fizika Tverdogo Tela, vol. 8, Sept. 1966, p. 2616-2622.)
Soviet Physics - Solid State, vol. 8, Mar. 1967, p. 2092-2097. 10 refs. Translation.

A67-21452
CONCERNING THE NUMBER OF MODES GENERATED IN SOLID STATE LASERS BY TRAVELLING AND STANDING WAVES.
S. G. Zeiger and E. E. Fradkin (Leningradskii Gosudarstvennyi Universitet, Leningrad, USSR).
(Fizika Tverdogo Tela, vol. 8, Sept. 1966, p. 2655-2659.)
Soviet Physics - Solid State, vol. 8, Mar. 1967, p. 2122-2125. 8 refs. Translation.
[For abstract see issue 01, page 86, Accession no. A67-10069]

A67-21454
FRACTURE OF LiF SINGLE CRYSTALS UNDER THE ACTION OF LASER RADIATION.
N. V. Volkova, V. A. Likhachev, S. M. Ryvkin, V. M. Salmanov, and I. D. Iaroshetskii (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR).
(Fizika Tverdogo Tela, vol. 8, Sept. 1966, p. 2668-2671.)
Soviet Physics - Solid State, vol. 8, Mar. 1967, p. 2133-2135. Translation.

A67-21455
EFFECT OF THE SURFACE ON THE CHARACTERISTICS OF INJECTION-TYPE SEMICONDUCTOR LASERS.
O. D. Knab, V. I. Magalias, A. S. Logginov, and A. S. Astaf'ev.
(Fizika Tverdogo Tela, vol. 8, Sept. 1966, p. 2768, 2769.)
Soviet Physics - Solid State, vol. 8, Mar. 1967, p. 2207, 2208. Translation.

A67-21457
SOME PROPERTIES OF GaAs LASERS WITH EPITAXIAL P-N JUNCTIONS AT ROOM TEMPERATURE.
L. M. Kogan, L. D. Libov, D. N. Nasledov, T. F. Nikitina, G. M. Strakhovskii, and B. V. Tsarenkov (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad; Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Fizika Tverdogo Tela, vol. 8, Sept. 1966, p. 2789-2791.)
Soviet Physics - Solid State, vol. 8, Mar. 1967, p. 2227, 2228. Translation.

A67-21460
EFFECT OF INJECTION CURRENT ON THE TIME DEPENDENCE OF THE EMISSION FROM GaAs LASERS.
N. G. Basov, Iu. A. Drozhbin, Iu. P. Zakharov, V. V. Nikitin, A. S. Semenov, B. M. Stepanov, A. M. Tolmachev, and V. A. Iakovlev (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Fizika Tverdogo Tela, vol. 8, Sept. 1966, p. 2816-2818.)
Soviet Physics - Solid State, vol. 8, Mar. 1967, p. 2254, 2255. Translation.

A67-21558
INVESTIGATION OF THE DIFFERENCE FREQUENCIES BETWEEN TWO LASERS [UNTERSUCHUNG DER DIFFERENZFREQUENZEN ZWISCHEN ZWEI LASERN].
H. Boersch, G. Herziger, and H. Lindner (Berlin, Technische Universität, I. Physikalisches Institut, Berlin, West Germany).
Zeitschrift für Physik, vol. 199, Jan. 27, 1967, p. 349-359. 5 refs. In German.

Investigation of the frequency stability of He-Ne lasers by heterodyning two laser resonators. For single-mode operation, it is shown the stability and spectral purity of laser frequency is accurately defined by the constancy and bandwidth of the beat frequencies. For multimode operation, beat frequencies are observed that are practically independent of the length of the resonator cavity. These frequencies are shown to be caused by the inevitable nonlinearities of the electronic circuit. V. P.

A67-22561
MUTUAL-IMPEDANCE PLASMA PROBE [SONDE DE PLASMA A IMPEDANCE MUTUELLE].
Owen Storey (Centre National de la Recherche Scientifique, Groupe de Recherches Ionosphériques, Saint-Maur-des-Fossés, Seine, France), Pascal Meyer, and Michel Aubry (Centre National d'Etudes des Télécommunications, Issy-les-Moulineaux, Seine-et-Oise, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 1, Jan. 4, 1967, p. 99-101. In French.

Development of a method for determining the electron density of a plasma from mutual impedance measurements obtained between

two pairs of spherical electrodes as a function of the frequency. The method is seen to have the advantage of being insensitive to perturbations arising from the ion layers at the electrodes. V. P.

A67-21568

A FLUID MIXING LASER.

Terrill A. Cool (Cornell University, Thermal Engineering Dept., Ithaca, N.Y.).

Applied Physics Letters, vol. 9, Dec. 15, 1966, p. 418-420. 5 refs.
NSF Grant No. GK-848.

Observation of helium-neon CW laser oscillations at 1.1523 μ in a high-velocity gas flow system using the rapid mixing of metastable helium atoms with initially unexcited neon. Some advantages over existing systems are (1) excitation of the upper laser level is achieved with no substantial coupled direct excitation of lower lying levels by impact from energetic electrons, (2) the mixing process is separated from the initial process of formation of metastables, and (3) some of the energy stored in the initial excitation of states of the first gas lying above the metastable states may be used in the relaxing flow because of the downward cascading of energy to the metastable states. B.B.

A67-21569

HIGH POWER AND EFFICIENCY IN CdS ELECTRON BEAM PUMPED LASERS.

C. E. Hurwitz (Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Mass.).

Applied Physics Letters, vol. 9, Dec. 15, 1966, p. 420-423. 16 refs.

Electron beam excitation of CdS crystals grown in an atmosphere of excess Cd has resulted in laser emission near 4900 Å with 350 W of peak output power and 26.5% overall (35% internal) power efficiency at temperatures as high as 110°K. Laser action was observed, although at considerably reduced levels of power and efficiency, at temperatures up to 250°K. The high performance of the lasers appears to be due to increased crystal uniformity and to the introduction or enhancement of highly efficient radiative transitions, both of which result from the Cd-rich growth conditions. (Author)

A67-21571

DIODE LASERS OF $Pb_{1-y}Sn_ySe$ AND $Pb_{1-x}Sn_xTe$.

J. F. Butler, A. R. Calawa, and T. C. Harman (Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Mass.).

Applied Physics Letters, vol. 9, Dec. 15, 1966, p. 427-429. 5 refs.

Infrared laser emission at a number of wavelengths between 9.4 and 13.7 μ has been obtained from diodes of $Pb_{1-y}Sn_ySe$ and $Pb_{1-x}Sn_xTe$ at 12 and 77°K. Diodes were fabricated from vapor-grown $Pb_{1-y}Sn_ySe$ and both vapor-grown and Bridgman-grown $Pb_{1-x}Sn_xTe$. Emission data indicate that, as in $Pb_{1-x}Sn_xTe$, the energy gap in $Pb_{1-y}Sn_ySe$ decreases with increasing Sn concentration, becoming zero at 12°K for some value of y within the range $0.11 \lesssim y \lesssim 0.14$. (Author)

A67-21575

PHASE LOCKING OF LASER MODES BY CONTINUOUS CAVITY LENGTH VARIATION.

P. W. Smith (Bell Telephone Laboratories, Inc., Crawford Hill Laboratory, Holmdel, N.J.).

Applied Physics Letters, vol. 10, Jan. 15, 1967, p. 51-53. 7 refs.

Phase locking of the longitudinal modes of a gas laser has been obtained by translating one of the cavity mirrors at a constant velocity. The velocity required to obtain locking depends almost linearly on excitation as long as only the fundamental transverse mode is oscillating. No plausible explanation has been found for these effects. (Author)

A67-21600

EXPERIMENTAL COMPARISON OF SCATTERING OF COHERENT AND INCOHERENT LIGHT.

F. S. Harris, Jr., G. C. Sherman (Aerospace Corp., Electronics Research Laboratory, El Segundo, Calif.), and F. L. Morse (Aerospace Corp., Space Physics Laboratory and Electronics Research Laboratory, El Segundo, Calif.).

(Rochester Conference on Coherence and Quantum Optics, 2nd, Rochester, N.Y., June 22-24, 1966, Paper.)
IEEE Transactions on Antennas and Propagation, vol. AP-15, Jan. 1967, p. 141-147. 17 refs.

Light scattering experiments have been performed using as sources a continuous-wave He-Ne gas laser radiating at 6328 Å and a high-pressure xenon arc lamp, which was limited to a 100-Å bandwidth centered at 6328 Å. Both sources were used to determine, as a function of scattering angle, the intensity of light scattered by latex spheres ranging in diameters from 0.088 to 3.49 μ. It was found that for the four particle sizes studied, the results agree to within the possible experimental error of 20% and ±1°. (Author)

A67-21602 *

LASER INTERFEROMETRY AND PHOTON SCATTERING IN PLASMA DIAGNOSTICS.

W. B. Johnson (Case Institute of Technology, Cleveland, Ohio).

IEEE Transactions on Antennas and Propagation, vol. AP-15, Jan. 1967, p. 152-162. 56 refs.
Research supported by the Case Institute of Technology Research Fund, NSF, and NASA.

Various methods for determining the characteristics of high-temperature plasmas using lasers are reviewed. Ordinary interferometric techniques are discussed with the extension of these ideas to active and passive laser cavity probing. It is seen that these methods well complement existing techniques for the determination of electron densities within the range $10^{10} \lesssim n_e \lesssim 10^{17}$ electrons/cm^3. Plasma probing using photon scattering is examined and it is shown that the electron density, electron temperature, and ion temperature may be found. In addition a considerable amount of information can be obtained which pertains to the kinetic theory of plasmas. Experimental detail pertaining to these methods is given along with their practical limitations. (Author)

A67-21613

SOME ASPECTS OF FRINGE COUNTING IN LASER INTERFEROMETERS.

W. R. C. Rowley (Ministry of Technology, National Physical Laboratory, Standards Div., Teddington, Middx., England).

(Institute of Electrical and Electronics Engineers, Conference on Precision Electromagnetic Measurements, Boulder, Colo., June 21-23, 1966, Paper.)
IEEE Transactions on Instrumentation and Measurement, vol. IM-15, Dec. 1966, p. 146-149. 7 refs.

A number of arrangements are possible for deriving signals in phase quadrature from interferometers, so that bi-directional counting of the interference fringe movements can be carried out. Arrangements which avoid splitting the image field are preferred for laser light sources, and can give a better signal-to-noise ratio. In environments where the interferometer is subjected to vibration, the fringe counting system may be required to handle rapid reversals in the direction of movement. In these circumstances the rate of production of rapid counting signals of alternate direction may be considerably reduced by using an appropriate logic system between the interferometer and the counter. (Author)

A67-21615

CALORIMETRIC MEASUREMENT OF PULSED LASER OUTPUT ENERGY.

D. A. Jennings (National Bureau of Standards, Boulder, Colo.).

(Institute of Electrical and Electronics Engineers, Conference on Precision Electromagnetic Measurements, Boulder, Colo., June 21-23, 1966, Paper.)
IEEE Transactions on Instrumentation and Measurement, vol. IM-15, Dec. 1966, p. 161-164. 7 refs.

We have designed, built, and calibrated calorimeters for measuring the output energy of the pulsed ruby laser (6943 Å). The heart of the calorimeter is a small absorption cell containing an

aqueous solution of $CuSO_4$. The temperature of the absorption cell, as measured by a thermocouple, indicates the energy absorbed by the calorimeter. The calorimeter was calibrated in two different ways: (1) the known heat capacity of the absorption cell and the thermocouple sensitivity calibration gives a calorimeter calibration - which agrees within 0.3% with (2) an electrical energy substitution calibration which is obtained via a heater wire contained in the absorption cell solution. A method has been devised by which two calorimeters may be intercompared. Calorimeters which we have built and calibrated agree with each other to about 0.7%. This specific calorimeter has been designed to measure energies up to 30 joules and will take peak powers of up to 200 Mw/cm^2. (Author)

A67-21640 *

GALLIUM ARSENIDE INJECTION LASER RADAR.
B. S. Goldstein (NASA, Electronics Research Center, Cambridge, Mass.) and G. F. Dalrymple (Massachusetts Institute of Technology, Lincoln Laboratory, Radar Div., Lexington, Mass.).
IEEE, Proceedings, vol. 55, Feb. 1967, p. 181-188. 17 refs.

Evaluation of the range capability of gallium arsenide (GaAs) laser radar against extended targets and corner reflectors under both negligible and high-background radiation conditions. The computations are carried out for a space environment. The operational results obtained with this radar in the atmosphere against several diffuse targets and a corner reflector are given. M.M.

A67-21642

A FAST RISETIME AVALANCHE TRANSISTOR PULSE GENERATOR FOR DRIVING INJECTION LASERS.
James P. Hansen and William A. Schmidt (U.S. Naval Research Laboratory, Washington, D.C.).
IEEE, Proceedings, vol. 55, Feb. 1967, p. 216, 217.

A circuit is described in which avalanche transistors in parallel generate high-current, fast risetime pulses suitable for driving injection lasers. A 55 A, 20 nsec risetime pulse was produced at a repetition rate of 10 kHz. An adjustable biasing technique makes possible the simultaneous avalanche of unmatched transistors. (Author)

A67-21643

LASER MODULATION - MINIMIZING HARMONIC DISTORTION WITH MULTIPLE CRYSTALS.
V. D. Woolley (Department of Supply, Weapons Research Establishment, New Devices Assessment Group, Salisbury, Australia).
IEEE, Proceedings, vol. 55, Feb. 1967, p. 217, 218.

The use of several electrooptic crystals provides a means of improving modulation depth for a given modulating voltage. An improvement in modulation linearity can also be achieved if a separate analyzer assembly is used with each crystal. (Author)

A67-21675

OPTICAL COMMUNICATIONS.
R. Kompfner (Bell Telephone Laboratories, Inc., Crawford Hill Laboratory, Holmdel, N.J.).
IN: WINCON '67; WINTER CONVENTION ON AEROSPACE AND ELECTRONIC SYSTEMS, 8TH, LOS ANGELES, CALIF., FEBRUARY 7-9, 1967, CONFERENCE RECORD. [A67-21674 09-08] Convention sponsored by the Aerospace and Electronic Systems Group and the Los Angeles Council of the Institute of Electrical and Electronics Engineers.
Los Angeles, Institute of Electrical and Electronics Engineers, Inc., Los Angeles Council (Winter Convention Series. Volume 6), 1967, p. IIA-1 to IIA-6. 16 refs.

Discussion of the elements of a laser communication system. The subject of millimeter waves for communication is reviewed, and it is pointed out that light not derived from an optical maser, such as light from an incandescent filament or an arc lamp, is of very limited utility for communication. Elements of a laser communication system discussed include transmission media, terminals and repeaters, generators, amplifiers, modulators, and detectors. M.F.

A67-21713

BIBLIOGRAPHY OF THE OPEN LITERATURE OF LASERS. VI.
Edward V. Ashburn (Lockheed Aircraft Corp., Lockheed-California Co., Burbank, Calif.) and Bela A. Lengyel (San Fernando Valley State College, Northridge, Calif.).
Optical Society of America, Journal, vol. 57, Jan. 1967, p. 119-148.

Bibliography of books and articles on lasers and laser applications published in 1966. The bibliography contains 984 references from 111 journals in the American and foreign open literature. The revised classification scheme that was used includes both laser applications and basic laser physics. The bulk of the material was compiled by conducting a machine search for key words in the titles of articles in 25 selected journals. M.F.

A67-21747 #

DIRECT OBSERVATION OF COMBINATION TONES DUE TO THIRD ORDER POLARIZATION OF AN ACTIVE LASER MEDIUM.
H. Boersch, G. Herziger, H. Lindner, and G. Makosch (Berlin, Technische Universität, I. Physikalisches Institut, Berlin, West Germany).
Physics Letters, vol. 24A, Feb. 13, 1967, p. 227, 228.

Description of the detection of combination tones of the three laser modes, as predicted by Lamb, by a coupled high-resolution optical amplifier. Simultaneously performed beat frequency measurements agree with the optically determined spacing between combination tones and original laser frequencies. B.B.

A67-21748 #

LASER PULSE DISTORTION IN A NONLINEAR DIELECTRIC.
R. J. Joenk and R. Landauer (International Business Machines Corp., Thomas J. Watson Research Center, Yorktown Heights, N.Y.).
Physics Letters, vol. 24A, Feb. 13, 1967, p. 228, 229. 5 refs.

Derivation of the velocities of the envelope and phase for a laser pulse propagating in a nonlinear dielectric with intensity dependent index of refraction. An estimate is made of the frequency shift due to the nonlinearity. B.B.

A67-21749 #

A NEW LASER Q-SWITCH-TECHNIQUE USING STIMULATED BRILLOUIN SCATTERING.
D. Pohl (München, Technische Hochschule, Physikalisches Institut, Munich, West Germany).
Physics Letters, vol. 24A, Feb. 13, 1967, p. 239, 240. In German.

Discussion of the use of intense stimulated Brillouin scattering in liquids for a passive Q-switch. The technique is said to be applicable to visible and IR lasers. Giant pulses of 100 Mw peak power and 25 nsec halfwidth are generated with a ruby and a Nd-glass laser. B.B.

A67-21765 #

OPERATION OF A LASER-PUMPED RUBY MASER AT 77°K.
Fujio Saito (Nippon Electric Co., Ltd., Central Research Laboratories, Kawasaki, Japan).
Japanese Journal of Applied Physics, vol. 6, Jan. 1967, p. 89-99. 24 refs.

Derivation of differential equations describing the time-dependent behavior of an optically pumped solid-state maser, using a self-consistent formalism based on the density matrix equation and the Maxwell equations. Results obtained by numerical integration of the equations are compared with experimental results. V.P.

A67-21769 #

Q-SWITCHED CO_2 LASER AND THE DETECTION WITH THE PYROELECTRIC THERMAL DETECTOR.
Mitsuyoshi Shimazu, Yasuzi Suzaki, Masamoto Takatsuji, and Katsumi Takami (Hitachi, Ltd., Central Research Laboratory, Tokyo, Japan).
Japanese Journal of Applied Physics, vol. 6, Jan. 1967, p. 120. 5 refs.

Description of a Q-switched CO_2 laser with an internal concave rotating mirror (radius of curvature = 3 m) mounted at one end of

a 2-m-long, 3-cm-diam discharge tube (discharge length = 180 cm). Oscillograms of Q-switched pulses observed with a triglycine-sulfate pyroelectric thermal detector are included. V. P.

A67-21825
STUDY OF ATMOSPHERIC TURBULENCE BY MEANS OF A LASER BEAM.
P. Burlamacchi and A. Consortini (Consiglio Nazionale delle Ricerche, Centro Microonde, Florence, Italy).
(Congrès International d'Optique, 7th, Conference on Recent Progress in Physical Optics, Paris, France, May 2-7, 1966, Paper.)
Optica Acta, vol. 14, Jan. 1967, p. 17-26. 12 refs.

Development of a method for determining the characteristic parameters of turbulence from an analysis of the deterioration of the spatial coherence of a laser beam after propagation in the atmosphere. The method proposed is based essentially on monitoring the diffraction pattern of a circular aperture. V. P.

A67-21916 #
EFFECT OF THE SPATIAL STRUCTURE OF A LASER BEAM ON SECOND-HARMONIC GENERATION IN ADP AND KDP CRYSTALS [VLIIANIE PROSTRANSTVENNOI STRUKTURY PUCHKA OPTICHESKOGO KVANTOVOGO GENERATORA NA GENERATSIIU VTOROI GARMONIKI V KRISTALLAKH ADP I KDP].
V. D. Volosov and E. V. Nilov.
Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 715-719. In Russian.

Study of the effectiveness of using cylindrical optics in converting laser emission into the second harmonic in ADP and KDP crystals. It is shown that the use of cylindrical optics makes it possible to obtain maximally high laser-emission conversion coefficients at comparatively low generator powers. The highest conversion coefficient, estimated as the ratio of the second-harmonic power to the power of the entire emission passing through the crystal, is obtained on a KDP crystal and amounts to 30%. The ADP crystal is found to possess greater resistance to light loads than KDP, the KDP crystal fracturing at specific loads on the order of 190 to 200 Mw/cm^2, while the ADP crystal fractures at 500 Mw/cm^2. A. B. K.

A67-21919 #
GABOR RESTORATION OF A WAVE FRONT BY MEANS OF A LASER [GABOROVSKOE VOSSTANOVLENIE VOLNOVOGO FRONTA S POMOSHCH'IU LAZERA].
I. S. Klimenko and G. I. Rukman.
Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 751, 752. 8 refs. In Russian.

Experimental study of the fixation of holograms by the Gabor single-beam method of wave-front restoration, using a gas laser as the light source. It is found that at the great distances from object to plane of fixation permitted by the use of a laser the noise background resulting from the superposition of a virtual image on the real image becomes less dense and more homogeneous, thus beneficially affecting the image quality. The absence of collimating optics is also found to have a beneficial effect on the image quality. The mechanics of the superposition of holograms by successive exposure of two holograms are considered. In this case it is found that not only are two virtual images superimposed on each real image, but also an unfocused real image of the other object. A. B. K.

A67-21920 #
ZEEMAN EFFECT IN A NEON HELIUM GAS LASER (λ = 6328 Å) [EFFEKT ZEEMANA V GAZOVOM OPTICHESKOM KVANTOVOM GENERATORE NA SMESI NEON-GELII (λ = 6328 Å)].
A. I. Povrozin and A. I. Sidorov.
Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 754-758. 6 refs. In Russian.

Results of a study of the Zeeman effect in a gas laser operating at the 6328-Å wavelength in a longitudinal magnetic field. The difference between the frequencies of the lines of the doublet emitted by the laser is found to depend on the magnitude of the longitudinal magnetic field, thus confirming the assumption that a simple Zeeman effect occurs in this case. A. B. K.

A67-21922 #
MEASUREMENT OF THE ELECTRON CONCENTRATION IN A XENON PULSE DISCHARGE BY MEANS OF A GAS LASER [IZMERENIE KONTSENTRATSII ELEKTRONOV V IMPUL'SNOM RAZRIADE V KSENONE S POMOSHCH'IU GAZOVOGO LAZERA].
A. G. Rozanov, N. V. Cheburkin, and N. N. Shvindt.
Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 761, 762. In Russian.

Measurement of the electron density in a xenon pulse discharge, using a laser interferometer. Using a He-Ne laser operating simultaneously at wavelengths of 0.63 and 3.39 μ, the maximum electron concentration is found to correspond to the maximum current and to be equal to 7.0×10^{17}/cm^3, with a measurement error of about 6%. A. B. K.

A67-21923 #
EMISSION POLARIZATION AND FREQUENCY CHARACTERISTICS OF ANNULAR LASERS WITH TRIANGULAR RESONATORS [O POLIARIZATSII IZLUCHENIIA I CHASTOTNYKH KHARAKTERISTIKAKH KOL'TSEVYKH LAZEROV S REZONATOROM TREUGOL'NOI FORMY].
S. N. Bagaev, Iu. V. Troitskii, and B. I. Troshin.
Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 768, 769. In Russian.

Study of the polarization of waves generated by annular laser resonators of triangular shape. It is shown that the electric-field vector of the waves generated in such a resonator can have only two directions - i.e., the vector may either lie in the resonator plane or be perpendicular to it. It is also shown that two mode systems are obtained on the amplification line for each vector direction. It is found that, by introducing a birefringent element into the resonator, these two mode systems can be made to coincide in a single system. A. B. K.

A67-21924 #
USE OF A MICROWAVE DISCHARGE AS THE ACTIVE MEDIUM OF A GAS-DISCHARGE LASER [OB ISPOL'ZOVANII MIKROVOLNOVOGO RAZRIADA V KACHESTVE AKTIVNOI SREDY GAZORAZRIADNOGO LAZERA].
A. I. Maksimov.
Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 770, 771. 7 refs. In Russian.

Calculation of the inversion population of the $2s_2$ and $2p_4$ neon levels during a microwave discharge in an He-Ne mixture with a 10:1 ratio of He to Ne. The results of the calculation are represented in the form of dependences of the difference between the populations of the $2s_2$ and $2p_4$ neon levels on the pressure at optimal electron concentrations and on the power scattered by a unit discharge volume. The maximum inversion is found to correspond to a pressure of about 5 mm Hg, a pressure at which the electron collision frequency is close to the frequency of the applied field. It is also found that with an increase in pressure the discharge power at which the inversion reaches a maximum decreases. A. B. K.

A67-21925 #
STIMULATED EMISSION IN THE NEGATIVE-LUMINESCENCE REGION OF A GLOW DISCHARGE [STIMULIROVANNOE IZLUCHEN V OBLASTI OTRITSATEL'NOGO SVECHENIIA TLEIUSHCHEGO RAZRIADA].
K. S. Mustafin, V. A. Seleznev, and E. I. Shtyrkov.
Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 780, 781. 5 refs. In Russian.

Detailed study of the generation characteristics in the negative-luminescence region of a glow discharge in a He-Ne mixture. The dependence of the generation output power on the total pressure and the ratio between the partial pressures of the mixture components is determined, as well as the dependence of the output power on the discharge current and the electrode voltage. The optimal partial-pressure ratio is found to be 0.02 and to correspond to the maximum normal cathode potential drop, as determined by Weston. A. B. K.

A67-21973 #
SEMICONDUCTOR LASER EMPLOYING GaAs UNDER OPTICAL EXCITATION BY RADIATION OF A QUANTUM ENERGY CLOSE TO THE WIDTH OF THE FORBIDDEN BAND [POLUPROVODNIKOVYI KVANTOVYI GENERATOR NA GaAs PRI OPTICHESKOM VOZBUZHDENII IZLUCHENIEM S ENERGIEI KVANTOV, BLIZKOI K SHIRINE ZAPRESHCHENNOI ZONY].
N. G. Basov, A. Z. Grasiuk, V. F. Efimkov, and V. A. Katulin (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Fizika Tverdogo Tela, vol. 9, Jan. 1967, p. 88-101. 14 refs. In Russian.

Experimental investigation of a GaAs laser pumped by the Stokes component of the induced Raman scattering in liquid nitrogen of Q-modulated ruby laser light. It is found that the excitation threshold is roughly equal to 250 kw/cm^2, the minimum spectral-line width during generation is equal to 4 A, the width of the radiation pattern is equal to 1.5 to 2°, the width of the generating layer is equal to 0.5 mm, the nonresonant absorption coefficient in the active substance (for nonequilibrium free carriers) is less than 0.4 cm^{-1}, the maximum efficiency is 47 ± 5%, and the maximum power generated is 200 kw. V.P.

A67-21975 #
INJECTION LUMINESCENCE OF EPITAXIAL HETEROJUNCTIONS IN THE GaP-GaAs SYSTEM [INZHEKTSIONNAIA LIUMINESTSENTSIIA EPITAKSIAL'NYKH GETEROPEREKHODOV V SISTEME GaP-GaAs].
Zh. I. Alferov, D. Z. Garbuzov, V. S. Grigor'eva, Iu. V. Zhiliaev, L. V. Kradinova, V. I. Korol'kov, E. P. Morozov, O. A. Ninua, E. L. Portnoi, V. D. Prochukhan, and M. K. Trukan (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR).
Fizika Tverdogo Tela, vol. 9, Jan. 1967, p. 279-282. 5 refs. In Russian.

Experimental investigation of the luminescence and photoluminescence spectra of n-$GaAs_{0.85}P_{0.15}$-p-GaAs and n-GaP-p-GaAs epitaxial heterojunctions obtained by the gas-transport method in an open system. It is shown that the use of p-GaAs as a narrow-band semiconductor makes it possible to obtain in such heterojunctions the conditions necessary to obtain a highly efficient one-sided injection. V.P.

A67-21985 #
ADJUSTMENT OF GAS LASER RESONATORS [JUSTÁŽ REZONÁTORŮ PLYNOVÝCH LASERŮ].
Jiří Kršek and Bohumír Popela (Československá Akademie Věd, Ústav Přístrojové Techniky, Brno, Czechoslovakia).
Jemná Mechanika a Optika, vol. 12, Feb. 1967, p. 41-45. 8 refs. In Czech.

Discussion of the adjustment of compound resonators, which provides an increase of stimulated emission output without lengthening the resonator. A process of precise adjustment of the discharge tube in the resonance cavity is described, and the precision of the methods used to make the adjustment is evaluated. M.F.

A67-22010
SPECTROSCOPIC STUDIES OF A LASER SPARK. I.
T. P. Evtushenko, A. N. Zaidel', G. V. Ostrovskaia, and T. Ia. Chelidze (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR).
(Zhurnal Tekhnicheskoi Fiziki, vol. 36, Aug. 1966, p. 1506-1513.)
Soviet Physics - Technical Physics, vol. 11, Feb. 1967, p. 1126-1130. 5 refs. Translation.

A67-22042
METHOD FOR LASER-BEAM CLEANING.
J. R. Christian and J. W. Mink (U.S. Army, Electronics Command, Institute for Exploratory Research, Fort Monmouth, N.J.).
Electronics Letters, vol. 3, Feb. 1967, p. 84, 85.

Discussion of a simple method for removing irregularities in laser beam output intensity distributions caused by internal reflections in the output mirror. The design equations for a lens and iris combination are given, and experimental results for one type of laser are shown. B.B.

A67-22043
FLUCTUATIONS IN THE AMPLITUDE OF OSCILLATION OF AN AMMONIA BEAM MASER.
A. L. S. Smith (St. Andrews University, St. Salvator's College, Dept. of Physics, St. Andrews, Scotland) and D. C. Lainé (Keele, University, Dept. of Physics, Keele, Staffs., England).
Electronics Letters, vol. 3, Feb. 1967, p. 90, 91. 7 refs.

Description of the results of measurements of fluctuations in the amplitude of oscillation of an ammonia beam maser. The fluctuations are found to increase as the level of oscillation falls, although near the oscillation level the experimental values are significantly below those predicted by the univelocity theory. B.B.

A67-22063
WAVE SYNCHRONIZATION IN A GAS LASER WITH A RING RESONATOR.
Iu. L. Klimontovich, V. N. Kuriatov, and P. S. Landa (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, July 1966, p. 3-12.)
Soviet Physics - JETP, vol. 24, Jan. 1967, p. 1-7. 7 refs. Translation.

A67-22065
LASER MODE INTERACTION IN THE COURSE OF Q-SWITCHING.
L. N. Magdich.
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, July 1966, p. 18-24.)
Soviet Physics - JETP, vol. 24, Jan. 1967, p. 11-15. 7 refs. Translation.

A67-22067
INVESTIGATION OF COLLISIONS WITH EXCITED ATOMS IN GAS LASERS.
A. S. Khaikin (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, July 1966, p. 38-48.)
Soviet Physics - JETP, vol. 24, Jan. 1967, p. 25-32. 14 refs. Translation.

A67-22068
STIMULATED RADIATION FROM $Y_3Al_5O_{12}$-Nd^{3+} CRYSTALS.
A. A. Kaminskii (Akademiia Nauk SSSR, Institut Kristallografii, Moscow, USSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, July 1966, p. 49-58.)
Soviet Physics - JETP, vol. 24, Jan. 1967, p. 33-39. 13 refs. Translation.

A67-22070
APPLICATION OF GAS LASERS TO THE DETERMINATION OF SOME ATOMIC CHARACTERISTICS.
A. K. Popov (Akademiia Nauk SSSR, Sibirskoe Otdelenie, Institut Fiziki, Krasnoyarsk, USSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, July 1966, p. 121-128.)
Soviet Physics - JETP, vol. 24, Jan. 1967, p. 81-86. 7 refs. Translation.

A67-22133
HERMITE-GAUSSIAN MODE PATTERNS IN GaAs JUNCTION LASERS.
J. C. Dyment (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
Applied Physics Letters, vol. 10, Feb. 1, 1967, p. 84-86. 11 refs.

Far-field radiation patterns with Hermite-Gaussian symmetry in the junction plane have been observed in both p^+nn^+ and p^+n^+ GaAs lasers specially constructed with a stripe geometry contact. The Hermite-Gaussian symmetry implies the presence of a lens-like medium between the cleavage plane mirrors. Compared with conventional junction lasers, improved mode control is obtained. (Author)

A67-22134
FREQUENCY STABILIZATION OF THE ZEEMAN LASER.
J. Kannelaud, D. G. Peterson, and W. Culshaw (Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Research Laboratories, Palo Alto, Calif.).
Applied Physics Letters, vol. 10, Feb. 1, 1967, p. 94-96. 9 refs.
Research supported by the Lockheed Independent Research Fund.

The intensity crossover region with cavity tuning between oscillations on two orthogonally circularly polarized axial modes of a Zeeman laser has been used to stabilize these oscillation frequencies with respect to the center of the atomic transition. In contrast to previously proposed stabilization schemes this method allows operation over a wide range of frequencies off the center of the atomic transition, providing step and vernier tuning. The stabilization method has been successfully applied to the 0.633-μ and 1.153-μ He-Ne and 2.65-μ Xe lasers. A frequency stability of one part in 10^{10} was obtained with the 2.65-μ Xe laser. (Author)

A67-22137
LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS.
University Park, Pa., Pennsylvania State University, 1966. 156 p. $7.00.

CONTENTS:

A67-22138 #
SOME ENERGY PROBLEMS IN LASER WELDING.
Harry E. Franks and C. M. Adams (Maser Optics, Inc., Boston, Mass.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 1-3.

Examination of the necessity of investigating the value of the maximum instantaneous heat flux that most metals can withstand. An equation is derived which is of interest only with relatively thick materials that challenge the capacity of the laser beam from the standpoint of total energy and therefore demand efficient use of heat. For thin-gage materials, the total energy requirements are so low that inefficient operation can be tolerated, and the problem is only to ensure that the instantaneous intensity of the pulse is low enough to avoid evaporation and expulsion of liquid metal. The maximum tolerable intensity is likely to be smaller for thin materials than for thick. M.M.

A67-22139 #
AN EVALUATION OF PULSED LASER WELDING.
J. E. Anderson and J. E. Jackson (Union Carbide Corp., Linde Div., Speedway Laboratories, Indianapolis, Ind.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 4-25.

Assessment of welding by means of the pulsed laser, reviewing the characteristics and limits of the process, applications, circuit board welding, and special welds. It is noted that a few process requirements that must be followed to ensure success with laser welding, are: (1) the location of the laser spot on the weldment should be within 20% of the characteristic dimension; (2) the distance between the laser and the workpiece should be within 2% of the focal length of the lens; (3) reactive materials require shielding, and therefore, when welding titanium, zircaloy, and other oxygen-sensitive materials, argon shielding is necessary; (4) symmetrical heat input is preferred; and (5) small weldments require lens systems with short focal length. For a given laser crystal, the focal length of the lens system and the size of the resultant laser spot are proportional. M.M.

A67-22140 #
THE LASER AS AN INDUSTRIAL MACHINING AND WELDING TOOL
Donald S. Young (Western Electric Co., Inc., Princeton, N.J.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 26-37.

Discussion of criteria to be met in using the laser industrially, treating theoretical considerations and experimental observations of laser welding. It is concluded that presently the laser is a specialized tool limited to specialized jobs. It is not in a position to compete economically with conventional industrial tools. There are indications, however, that advances in laser technology will eventually

make the laser competitive with conventional tools in terms of both operating and capital costs. Several improvements are needed before the laser can be considered a universal welding or machining tool. The two principal factors that now limit the laser to a few welding applications and drilling holes without precise tolerances are pulse control and efficiency. M. M.

A67-22141 #
DEVELOPMENT OF AN INDUSTRIAL LASER WELDER.
S. Donald Sims (TRG, Inc., Melville, N. Y.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 38-60.
Contract No. AF 33(657)-8799.

Description of a laser welder designed and built between 1962 and 1964 as part of a program to achieve the timely development of manufacturing processes, techniques, and equipment for use in the economical production of USAF materials and components. The topics treated include the application of lasers to fusion welding, physical properties of aerospace materials, design objectives and investigations of the laser welding system, properties of the ruby laser, theory for ruby laser power output, dimensions of the laser rod, ruby cooling techniques, and coatings and reflection. Other topics examined are the flash tube, energy and pulse requirements for welding, design of the laser beam welding system, the power supply, design and constraints of pulse-forming network, and final characteristics and tests. M. M.

A67-22142 #
THE LASER AS A DRILLING TOOL.
David L. Williams (General Electric Co., Advanced Technology Laboratories, Schenectady, N. Y.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 61-71.

Description of the results of investigations of laser drilling, together with some of the problems involved. The laser used in the experiment is energized from a conventional power supply, and the laser beam is focused with lenses. The laser is shown together with the drilling setup. It is pointed out that the work performed to date has partially considered the variables that seemed pertinent and that many of the laser-drilled holes, particularly those with larger depth-to-width ratios, compare quite favorably with holes produced by electron beam techniques; furthermore, the laser requires considerably less setup time. The laser can already accomplish certain machining tasks that are difficult or impossible by other techniques, such as angular machining and the forming of extremely small holes in hard materials. M. M.

A67-22144 #
EFFECTS OF LASER RADIATION ON SOLIDS.
John F. Ready (Honeywell, Inc., Research Center, Hopkins, Minn.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 85-95. 13 refs.

Discussion of the types of effects produced by laser radiation. The interaction of laser radiation with solid materials is examined, and heating effects of the radiation are calculated, together with the amount of material that is expected to be vaporized. The effects of laser radiation on welding and machining in particular are considered. M. M.

A67-22145 #
INDUSTRIAL LASER APPLICATIONS.
T. A. Osial, K. B. Steinbrugge, and P. H. Scharf (Westinghouse Electric Corp., Atomic, Defense and Space Group, Research and Development Center, Research Laboratories, Pittsburgh, Pa.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 96-107. 7 refs.

Discussion of industrial applications of lasers, giving background information on laser theory. In their present state of development, optically pumped solid-state lasers are not suited for gross removal of material or for large welding applications, because of limitations on the achievable high average power. But their inherent characteristics permit these lasers to spotweld and drill under conditions either not feasible or impossible with more conventional techniques. M. M.

A67-22146 #
CONTROL OF LASER ACTION.
D. E. Flinchbaugh, A. J. DeMaria, and G. E. Danielson, Jr. (United Aircraft Corp., United Aircraft Research Laboratories, East Hartford, Conn.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 108-120. 13 refs.

Demonstration of the application of acoustic cells to solid-state laser output control and to relatively large-angle scanning of a gas laser beam. It is pointed out that with the basic understanding gained, many design refinements for practical systems are becoming apparent. Already valuable in performing ultrasonic cleaning, the focusing transducer should achieve new status in optical radar and imaging systems, and possibly in the control of large radiation-welding or weapons systems. M. M.

A67-22147 #
LASER WELDING OF AEROSPACE MATERIALS.
James R. Kennedy (Grumman Aircraft Engineering Corp., Bethpage, N. Y.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 121-127.

Description of an investigation of a laser device with high energy output for use as an industrial tool for fusion welding of advanced structural alloys. The primary objective of the work was to demonstrate that a high energy pulsed laser has the capability of producing reliable and consistent weld joints in selected materials typical of aerospace structural applications. The evaluation is based mainly on results obtained through study of each of the following general areas: (1) laser welding techniques and procedures, (2) mechanical properties of weld joints at various temperatures, (3) mechanism of laser bonding, (4) metallurgical effects on parent material, and (5) equipment versatility. M. M.

A67-22148 #
LASERS FOR LENGTH MEASUREMENT.
Klaus D. Mielenz (National Bureau of Standards, Metrology Div., Washington, D. C.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 132-142. 12 refs.

Discussion of techniques and experiments for length measurements by means of lasers. To measure its absolute wavelength

stability, the laser wavelength must be compared to a wavelength standard. For such measurements a scanning Fabry-Pérot spectrometer may be used, illuminated by the laser under test and the green line of Hg 198. A portion of the Fabry-Pérot pattern is recorded, consisting of two adjacent Hg fringes with a laser fringe between them. On the interferogram thus obtained the distance between the two Hg fringes, as well as the distance between the laser fringe and one of the Hg fringes, is measured. Hence the fractional position of the laser fringe is expressed in terms of the Hg fringe separation. From a series of such measurements taken at regular intervals, the absolute changes of the laser wavelength are obtained as a function of time. M. M.

A67-22149 #
A PRACTICAL LASER INTERFEROMETER.
J. Engeman (Cutler-Hammer, Inc., Airborne Instruments Laboratory Div., Deer Park, N.Y.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 143-151. 5 refs.

Description of the development, design and operation of the laser interferometer, a practical device for the precise measurement of long distances. The type 169 laser interferometer consists of three main parts: (1) a sensor unit containing the laser light source, optics, and photoelectric detectors. An auxiliary telescope is also provided to simplify alignment with the machine axis; (2) a reflector unit, which is normally mounted on the movable table and contains a trihedral prism; and (3) a control cabinet, which houses the forward-backward counter, digital computer, temperature and pressure compensation circuits, and the visual display. M. M.

A67-22150 #
LASER INTERFEROMETRY AND SOME APPLICATIONS.
Frits Zernike, Jr. (Perkin-Elmer Corp., Norwalk, Conn.).
IN: LASER WELDING AND MACHINING; ENGINEERING SEMINAR ON NEW INDUSTRIAL TECHNOLOGIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA., JUNE 27-JULY 2, 1965, PAPERS. [A67-22137 09-15]
University Park, Pa., Pennsylvania State University, 1966, p. 152-156.

Discussion of different applications of laser interferometry. In a particular application for detecting rotation in a system, a modified Michelson two-beam interferometer was used in which light from a source was split by a beamsplitter into two coherent beams. By suitably arranged mirrors the coherent beams were made to travel around a closed circuit in opposite directions but along identical paths, and then were combined again at the beamsplitter and brought to interference. Rotation of this system produced a fringe shift measured in fringe numbers. The 1925 experiment of Michelson and Gale is described. M. M.

A67-22170 #
SMALL-SIZE He-Ne LASER [LASER He-Ne O MAŁYCH ROZMIARACH].
Wiesław Wolinski, Tadeusz Adamowicz, Marian Nowicki, and Dyonizy Kwaśniewski (Warszawa, Politechnika, Katedra Przyrzadów Elektronowych, Warsaw, Poland).
Przegląd Elektroniki, vol. 8, Jan. 1967, p. 1-5. In Polish.

Discussion of the design of a CW helium-neon laser pumped by dc discharges in a resonant cavity 300-mm long. The current-voltage characteristic and the current-dependence of the output power are examined for the 300-mm laser and a version of it employing a 600-mm long resonant cavity. The results are given in diagram form. V. P.

A67-22171 #
HEADS OF A HIGH-ENERGY NEODYMIUM LASER [GŁOWICE LASERA NEODYMOWEGO O DUŻEJ ENERGII].
Bohdan Paszkowski, Wiesław Wolinski, Marian Nowicki, Tadeusz Adamowicz, Antoni Kaźmirowski, Dyonizy Kwaśniewski (Warszawa, Politechnika, Katedra Przyrzadów Elektronowych, Warsaw, Poland), and Andrzej Kowalski (Polskie Zakłady Optyczne, Poland).
Przegląd Elektroniki, vol. 8, Jan. 1967, p. 6-8. In Polish.

Discussion of the design of universal rotating mirrors used for Q-switching neodymium-glass lasers. The results obtained (percent reflection vs wavelength) with a rotating double-elliptical mirror and a rotating cylindrical mirror are examined and are diagramed. V. P.

A67-22251
INTERNATIONAL CONFERENCE ON MICROWAVE AND OPTICAL GENERATION AND AMPLIFICATION, 6TH, CAMBRIDGE, ENGLAND, SEPTEMBER 12-16, 1966, PROCEEDINGS.
Conference sponsored by the Electronics Division of the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers.
London, Institution of Electrical Engineers (IEE Conference Publication No. 27), 1966. 535 p. In English, French, and German. Members, $14.; nonmembers, $21.

CONTENTS:

A67-22269

INTERNAL MODULATION OF A GAS LASER AT 100 AND 4000 MHZ [MODULATION INTERNE DU LASER A GAZ A 100 MHZ ET 4000 MHZ]

Nguyen Ngoc Chau and J. Henaff (Centre National d'Etudes des Télécommunications, Issy-les-Moulineaux, Seine, France).

IN: INTERNATIONAL CONFERENCE ON MICROWAVE AND OPTICAL GENERATION AND AMPLIFICATION, 6TH, CAMBRIDGE, ENGLAND, SEPTEMBER 12-16, 1966, PROCEEDINGS. [A67-22251 09-09]

Conference sponsored by the Electronics Division of the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers.

London, Institution of Electrical Engineers (IEE Conference Publication No. 27), 1966, p. 379-383. 11 refs. In French.

Research supported by the Délégation Générale à la Recherche Scientifique et Technique.

Theoretical and experimental study of gas-laser modulation, using a modulator placed inside the laser cavity. A brief description is given of the electromagnetic field in a Fabry-Pérot resonator in terms of the natural-oscillation modes and the coupling of these modes by an internal modulator. The results of experiments carried out with an internally modulated laser at 100 and 4000 MHz are cited.

A. B. K.

A67-22270

AN L-BAND RUTILE TRAVELING-WAVE MASER.

E. L. Kollberg and K. S. Yngvesson (Chalmers Institute of Technology, Research Laboratory of Electronics, Gothenburg, Sweden).

IN: INTERNATIONAL CONFERENCE ON MICROWAVE AND OPTICAL GENERATION AND AMPLIFICATION, 6TH, CAMBRIDGE, ENGLAND, SEPTEMBER 12-16, 1966, PROCEEDINGS. [A67-22251 09-09]

Conference sponsored by the Electronics Division of the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers.

London, Institution of Electrical Engineers (IEE Conference Publication No. 27), 1966, p. 384-388. 12 refs.

Research supported by the Swedish Technical Research Council.

Description of a successful traveling-wave maser (TWM). The TWM was designed to be employed in hydrogen line radio astronomy work, for which an instantaneous bandwidth of a few MHz and a tunability of about 100 MHz around 1420 MHz is required. The gain expression for a TWM is written as $G_{db} = 27.3\ SN\chi''_+\eta$. Here S is the slowing factor of the slow-wave structure (SWS), N is the length of the maser divided by the free space wavelength at the signal frequency, η is the filling factor and χ''_+ is the imaginary part of the inverted susceptibility of the maser material at the resonance frequency assuming circular polarization. Special attention has been paid to maximizing χ''_+ and S in the design.

M. M.

A67-22271

DETERMINATION OF SYMMETRICAL GAIN CURVES IN MULTI-FREQUENCY OPTICAL OSCILLATORS.

B. Hill and H. Brand (Aachen, Technische Hochschule, Institut für Hochfrequenztechnik, Aachen, West Germany).

IN: INTERNATIONAL CONFERENCE ON MICROWAVE AND OPTICAL GENERATION AND AMPLIFICATION, 6TH, CAMBRIDGE, ENGLAND, SEPTEMBER 12-16, 1966, PROCEEDINGS. [A67-22251 09-09]

Conference sponsored by the Electronics Division of the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers.

London, Institution of Electrical Engineers (IEE Conference Publication No. 27), 1966, p. 395-398.

Experimental determination of the gain curve of an active medium by measuring vanishing frequencies as a function of the additional losses in the resonator. It was found that, in order to produce the additional loss experimentally, the attenuator must be variable in magnitude without changing the total phase shift of the passing light waves. An arrangement that satisfies this condition is shown. The discharge tube of the laser is limited on both sides with Brewster windows and a second glass tube is placed in line along the same axis. By rotation of this attenuator tube through a certain angle with reference to the main plane of incidence of the discharge tube, the plane of beam polarization rotates about an angle so that at each Brewster window a part of the beam is reflected.

M. M.

A67-22272
MECHANISMS OF ELECTRON BEAM EXCITATION OF ION LASERS.
J. M. Hammer and C. P. Wen (Radio Corporation of America, RCA Laboratories, Princeton, N.J.).
IN: INTERNATIONAL CONFERENCE ON MICROWAVE AND OPTICAL GENERATION AND AMPLIFICATION, 6TH, CAMBRIDGE, ENGLAND, SEPTEMBER 12-16, 1966, PROCEEDINGS. [A67-22251 09-09]
Conference sponsored by the Electronics Division of the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers.
London, Institution of Electrical Engineers (IEE Conference Publication No. 27), 1966, p. 399-403. 10 refs.

Measurements of cross sections for the production of excited argon ions by the impact of electrons with ground state neutral atoms. Peak values of about 5×10^{-19} cm^2 were found for the excitation of levels of some of the strong argon ion laser lines. The results obtained indicate that such direct excitation is not important in the conventional noble gas ion laser but is the chief means of pumping the triode or electron-beam type of ion laser. The (4p) upper state cross sections were found by studying the incoherent light produced by a triode-type structure filled with argon. By measuring the increase in coherent output obtained by operating the triode in an argon-ion-laser cavity, estimates of the lower laser level excitation cross sections were obtained. M. M.

A67-22273
AMPLIFICATION AND DETECTION OF HIGH-POWER LASER PULSES AT 10.6 μm.
A. F. Gibson, T. P. Hughes, and M. F. Kimmitt (Essex, University, Colchester, Essex, England).
IN: INTERNATIONAL CONFERENCE ON MICROWAVE AND OPTICAL GENERATION AND AMPLIFICATION, 6TH, CAMBRIDGE, ENGLAND, SEPTEMBER 12-16, 1966, PROCEEDINGS. [A67-22251 09-09]
Conference sponsored by the Electronics Division of the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers.
London, Institution of Electrical Engineers (IEE Conference Publication No. 27), 1966, p. 406-410. 12 refs.

Description of a 10.6-μ oscillator that can produce pulses rising to 10 kw in less than 1/2 μsec, giving a mean k value exceeding 2×10^{10} watts/sec over this period. The present amplifier has a gain coefficient of 1.0 db per meter. It is pointed out that a G_0 of 10^3 will be achieved in an extended amplifier 30 m long. With the higher-gain coefficient reported, superradiance sets a limit of about 30 m to the useful length of a wide oscillator tube. A 30-m tube with a gain coefficient of 3 db/m might make possible very short pulses with peak powers approaching 1 Gw. M. M.

A67-22274
COUPLED OPTICAL OSCILLATORS.
P. W. Pheneger and R. H. Pantell (Stanford University, W. W. Hansen Laboratories of Physics, Microwave Laboratory, Stanford, Calif.).
IN: INTERNATIONAL CONFERENCE ON MICROWAVE AND OPTICAL GENERATION AND AMPLIFICATION, 6TH, CAMBRIDGE, ENGLAND, SEPTEMBER 12-16, 1966, PROCEEDINGS. [A67-22251 09-09]
Conference sponsored by the Electronics Division of the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers.
London, Institution of Electrical Engineers (IEE Conference Publication No. 27), 1966, p. 411-424. 5 refs.
NSF Grant No. GK-616.

Analytical and experimental investigation of the problems of laser quenching and control of transient buildup, using a rate equation analysis. A single-mode rate equation analysis was made of the behavior of two coupled lasers. Transient solutions applicable to pulsed ruby lasers were examined, and quenching of one oscillation by another was predicted. Quantitatively, the theory agrees well with results of quenching experiments. Parameters in the theory were varied, and it was found that under certain conditions the spiking of the quenching laser could be tremendously suppressed. It was also seen from the single-mode theory that the spike suppression depended critically on the delay time between the firings of the lasers. M. M.

A67-22275
CONTRIBUTION TO GaAs LASER DIODES [EIN BEITRAG ZU GaAs-LASERDIODEN].
H. Beneking and W. Vits (Aachen, Technische Hochschule, Institut für Halbleitertechnik, Aachen, West Germany).
IN: INTERNATIONAL CONFERENCE ON MICROWAVE AND OPTICAL GENERATION AND AMPLIFICATION, 6TH, CAMBRIDGE, ENGLAND, SEPTEMBER 12-16, 1966, PROCEEDINGS. [A67-22251 09-09]
Conference sponsored by the Electronics Division of the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers.
London, Institution of Electrical Engineers (IEE Conference Publication No. 27), 1966, p. 429-434. In German.

Experimental investigation of the effect of crystal orientation on the epitaxial growth GaAs crystals from the liquid state employed by Nelson as a method of achieving very smooth p-n junctions in the preparation of laser diodes. Tests with <100>- and <111>-oriented crystals, performed to study the smoothness of the p-n junctions and the quality of the diodes, showed that diodes made of <100>-oriented crystals exhibit equally good laser properties (at a somewhat higher threshold current density) as diodes with a p-layer grown at the Ga part of a (111) plane, the laser efficiency being 50 to 60% in both cases. However, the exponential increase in light intensity and its final value are much lower for the latter. V. P.

A67-22276
THEORETICAL STUDIES OF SELF-FOCUSING A LASER BEAM IN AN INHOMOGENEOUS PLASMA.
A. R. M. Rashad (Memphis State University, Memphis, Tenn.).
IN: INTERNATIONAL CONFERENCE ON MICROWAVE AND OPTICAL GENERATION AND AMPLIFICATION, 6TH, CAMBRIDGE, ENGLAND, SEPTEMBER 12-16, 1966, PROCEEDINGS. [A67-22251 09-09]
Conference sponsored by the Electronics Division of the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers.
London, Institution of Electrical Engineers (IEE Conference Publication No. 27), 1966, p. 445-449. 9 refs.

Investigation of the possibility of propagating a laser beam in a plasma medium without spreading by ordinary diffraction - i.e., self-focused in a plasma. From the results of this study it is concluded that self-focusing may be accomplished provided certain conditions concerning the dielectric constant of the plasma and the power of the laser beam are satisfied. M. M.

A67-22362
LASERS AND THEIR APPLICATION TO TELEVISION SYSTEMS.
Marvin E. Lasser (Philco Corp., Applied Research Laboratory, Blue Bell, Pa.).
IEEE Transactions on Broadcasting, vol. BC-13, Jan. 1967, p. 1-5. 23 refs.

The paper discusses characteristics of the different laser sources with particular emphasis on the display output power needs. There are a number of nonlinear optical effects that appear useful to display systems; of particular interest for displays are the effects related to the controllable change of the wavelength of coherent radiation incident on the nonlinear media. The nonlinear techniques discussed are those related to harmonic generation, Raman laser action, and optical parametric amplification and oscillation. Calculations on the parametric oscillation effect show that a one watt blue or UV laser can effectively provide the optical pumping which would result in a very appreciable tunable optical output over the visible spectrum. Implicit in most applications for lasers in displays is the need to electro-optically deflect the laser beam. The results reported recently in this area are discussed. Finally, true three-dimensional image presentation appears feasible utilizing a laser light source and

a two-dimensional interference pattern. Some recent work in this area will also be discussed. (Author)

A67-22373

APPARENT SIZE AND HUE VARIATIONS OF A LASER LIGHT SPOT.

H. John Caulfield (Texas Instruments, Inc., Dallas, Tex.).

Human Factors, vol. 8, Oct. 1966, p. 435-440. 9 refs.

Both the apparent size and the apparent hue of a single spot of 6328 Å laser light vary with varying conditions, and with the particular observer. The apparent radius of a spot can vary from zero to several times the objectively determined radius as the background lighting conditions are changed. The general features of this variation are predictable theoretically. The apparent hue of the center of a laser spot can shift as much as 340 Å. Previous theory for the hue shift is shown to be inadequate, but no fully adequate theory is suggested. (Author)

A67-22430

EFFECTS OF GAMMA-IRRADIATION ON THE CHARACTERISTICS OF A RUBY LASER.

V. R. Johnson (Microwave Electronics Corp., Palo Alto, Calif.) and R. W. Grow (Utah, University, Dept. of Electrical Engineering, Salt Lake City, Utah).

IEEE Journal of Quantum Electronics, vol. QE-3, Jan. 1967, p. 1-7. 20 refs.

NSF Grants No. GK-29; No. GP-843.

Study of the possibility of increasing the efficiency of a ruby laser by gamma irradiation. It is found that an increase in the absorption cross section responsible for optical pumping of a ruby laser occurs as a result of gamma irradiation. Thermoluminescence data are presented showing that electron traps with activation energies of about 0.64 and 0.76 ev are formed in ruby as a result of gamma irradiation. It is found that the threshold energy for laser action increases in relation to the amount of irradiation. A model is devised to explain the changes in Cr^{+++} ions due to gamma irradiation and to show how this affects laser action. Theoretical curves are presented indicating how the energy output vs energy input varies with the amount of gamma irradiation. On the basis of the observed increase in threshold energy, the possibility of higher efficiencies than possible before irradiation is suggested. A. B. K.

A67-22431

DYNAMIC BEHAVIOR OF GAS LASERS.

Teiji Uchida (Nippon Electric Co., Ltd., Central Research Laboratories, Gas Laser Group and Light Modulation Group, Tokyo, Japan).

IEEE Journal of Quantum Electronics, vol. QE-3, Jan. 1967, p. 7-16. 21 refs.

Systematic treatment of the properties of gas lasers with respect to internal modulation, mode locking, perturbation of modes due to combination tones, and noise due to spontaneous emission. The response of gas lasers to resonator loss modulation and small-external-signal injection is investigated on the basis of Lamb's optical maser theory. It is found by an analysis of low-frequency loss modulation that each oscillating mode in a gas laser has its own damping constant or cutoff frequency for both types of perturbations. By analysis of small-external-signal injection, mode-locking criteria are obtained, and the complex perturbation of oscillating modes due to it is clarified. It is explained that the combination tones due to the nonlinearity of the laser medium, which are equivalent to externally injected

A67-22432

SELF LOCKING OF GAS LASERS.

T. Uchida (Nippon Electric Co., Ltd., Central Research Laboratories, Gas Laser Group and Light Modulation Group, Tokyo, Japan) and A. Ueki (Nippon Electric Co., Ltd., Central Research Laboratories, Tokyo, Japan).

IEEE Journal of Quantum Electronics, vol. QE-3, Jan. 1967, p. 17-30. 24 refs.

Investigation of the self-locking behavior of 6328-Å He-Ne gas lasers at various mirror separations by controlling the oscillation intensity with the aid of an intracavity modulator. It is found that a self-locked gas laser with m light pulses bouncing back and forth between both mirrors oscillates ordinarily at the mf_p mode interval (f_p is the fundamental axial mode interval) and exceptionally at the $1f_p$ mode interval. It is shown that ordinary self-locking (mf_p locking) easily occurs around a certain curve plotted as a function of internal oscillation power and pulse repetition rate or oscillating mode interval, regardless of the multiplicity m. The power-dependent transition from $1f_p$ to $2f_p$ self-locking is illustrated by the power dependence of the effective damping constant. It is shown that in order to realize mf_p self-locking the relative positions of the discharge tube and both mirrors must be chosen so as to make the 2m-th spatial Fourier component of the excitation density predominant over the other components. A. B. K.

A67-22433

VISUAL DISPLAY OF INFRARED LASER OUTPUT ON THERMOGRAPHIC PHOSPHOR SCREENS.

J. D. McGee and L. J. Heilos (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).

IEEE Journal of Quantum Electronics, vol. QE-3, Jan. 1967, p. 31.

Description of a method of achieving a visual display of the output patterns of IR lasers with the aid of heat-sensitive phosphors. Experiments are carried out using three different types of substrate (mylar sheet, asbestos paper, and aluminum sheet). The mylar sample is found to be the most sensitive at most wavelengths, the asbestos screen being slightly less sensitive, and the aluminum substrate showing the poorest sensitivity. The sensitivity of all three screens is found to increase sharply to about 1 mw/cm^2 for beams with wavelengths in the vicinity of 1 μ, thus suggesting the involvement of an additional physical mechanism at these wavelengths. A. B. K.

A67-22477

INTERNATIONAL COLLOQUIUM ON MICROWAVE RECEIVERS WITH LOW NOISE, PARIS, FRANCE, MAY 23-27, 1966, COMMUNICATIONS [COLLOQUE INTERNATIONAL RECEPTEURS MICRO-ONDES A FAIBLE BRUIT, PARIS, FRANCE, MAY 23-27, 1966, COMMUNICATIONS].

L'Onde Electrique, vol. 47, Jan. 1967. 133 p. In French.

CONTENTS:

A67-22481
DESIGN OF A MASER FOR TRAVELING WAVES OVER A LARGE BAND AT CENTIMETER WAVELENGTHS [REALISATION D'UN MASER A ONDES PROGRESSIVES A LARGE BANDE EN ONDES CENTIMETRIQUES].
A. Nizery and B. Loriou (Centre National d'Etudes des Télécommunications, Lannion, Côtes-du-Nord, France).
(Colloque International Récepteurs Micro-Ondes à Faible Bruit, Paris, France, May 23-27, 1966, Communication.)
L'Onde Electrique, vol. 47, Jan. 1967, p. 121-128. 9 refs. In French.
Discussion of the design of a ruby maser for traveling waves having a relatively large passband and designed for use as a low-noise amplifier in a space telecommunications center. A large-scale installation is at present being designed for the setting-up at Pleumeur-Bodou of the maser and superconductor magnetic apparatus. M.F.

A67-22482
ADVANTAGES IN THE USE OF SUPERCONDUCTOR WINDINGS IN A MASER [AVANTAGES DE L'EMPLOI DE BOBINAGES SUPRACONDUCTEURS DANS UN MASER].
J. Grangeon (Compagnie Française Thomson-Houston, Service Technique d'Etudes Avancées, Bagneux, Seine, France).
(Colloque International Récepteurs Micro-Ondes à Faible Bruit, Paris, France, May 23-27, 1966, Communication.)
L'Onde Electrique, vol. 47, Jan. 1967, p. 129-133. In French.
Theoretical and experimental study showing that the operation of a maser-type amplifier requires the presence of a continuous magnetic field that satisfies certain conditions of stability, size, orientation, uniformity, and controllability. The advantages and disadvantages of various ways of obtaining this magnetic field are examined, and the marked superiority of superconductor windings is shown. An example of a cavity maser using these types of magnetic field generator is given. M.F.

A67-22583
LIGHT EMISSION BY A GAS UNDER THE ACTION OF AN INTENSE LASER EMISSION [EMISSION DE LUMIERE PAR UN GAZ SOUS L'EFFET D'UN RAYONNEMENT LASER INTENSE].
Vincent Chalmeton and Renaud Papoular (EURATOM and Commissariat à l'Energie Atomique, Groupe de Recherches sur la Fusion, Fontenay-aux-Roses, Seine, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 3, Jan. 16, 1967, p. 213-216. In French.
Study of the light emitted by a gas during the first stage of a laser discharge. Using a high-speed, high-sensitivity photomultiplier, a number of new findings are made concerning the light emitted by a gas at the focus of a convergent laser beam. In particular, it is found that if the gas pressure or the laser energy is fairly high, the instant at which the light first appears corresponds to a laser power far below the threshold power. This fact is said to be incompatible with the hypothesis that the initial electrons are liberated by the multiphoton effect. A.B.K.

A67-22600
STUDY OF GaSb INJECTION LASERS [SUR L'ETUDE DES LASERS A INJECTION AU GaSb].
Bernard Pistoulet, Georges Bougnot, Henry Mathieu, and Georges Sagnes (Montpellier, Université, Centre d'Etudes d'Electronique des Solides, Montpellier, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 5, Jan. 30, 1967, p. 393-396. 6 refs. In French.
Study of the output and the emission spectra of p-n junction diodes formed by doping the melt during the pulling of a GaSb single crystal. A comparative study is made of the emission of these diodes at 77 or 85°K, on the one hand, and at 20°K, on the other. From curves of the overall emission plotted as a function of the injection level, it is found that the threshold current is rather variable from one diode to another. The ratio of the energy emitted to the electrical energy input is found to be 3% for the best diodes studied. The spectral distribution of the emitted radiation is determined. A.B.K.

A67-22615 #
A RADIOMETER FOR CONTINUOUS WAVE LASER RADIATION.
J. W. Stearn (Ministry of Aviation, Royal Radar Establishment, Great Malvern, Worcs., England).
Journal of Scientific Instruments, vol. 44, Mar. 1967, p. 218, 219.
Description of a power monitor designed to measure the radiated power from continuous-wave lasers operating in the visible and near infrared bands. The device described is distinguished by the fact that it is absolutely calibrated and relies on the flow of heat through a standard thermal impedance establishing a temperature gradient which is measured. The device can be designed for any power level in excess of 10 mw and its response time (from 0 to 90% of the final value) is approximately 1 min. A.B.K.

A67-22622
A DIGITAL LASER RANGEFINDER FOR DATA ACQUISITION.
Julian L. Thompson and Thomas R. Stoner (U.S. Navy, Bureau of Weapons, Naval Ordnance Test Station, China Lake, Calif.).
(Society of Photo-optical Instrumentation Engineers, Technical Symposium, 11th, St. Louis, Mo., Aug. 22-26, 1966, Paper.)
SPIE Journal, vol. 5, Dec. 1966-Jan. 1967, p. 47-53.
Discussion of test results for a pulsed ruby laser rangefinder installed at a test range of the U.S. Naval Ordnance Test Station at China Lake, Calif. The rangefinder, designed to perform data acquisition for determining trajectories of airborne targets, has pulse repetition frequencies up to 10 per second for meaningful data from high speed targets and also digital range readout. The topics discussed include constructional details, performance goals, and the degree to which these goals have been met. Some operational difficulties are indicated and analyzed. Remedial measures are proposed. V.Z.

A67-22659
EMISSION OF A SHORT SINGLE PULSE BY AN INJECTION SEMICONDUCTOR LASER.
V. D. Kurnosov, A. A. Pleshkov, G. S. Petrukhina, L. A. Rivlin, V. G. Trukhan, and V. V. Tsvetkov.
(ZHETF Pis'ma v Redaktsiiu, vol. 5, Feb. 1, 1967, p. 77, 78.)
JETP Letters, vol. 5, Feb. 1, 1967, p. 63. Translation.
Successful attempt to obtain a short single pulse in an injection semiconductor laser. The pulse was obtained in a GaAs diode with a diffusion p-n junction and a resonator produced by cleavage, following excitation by a 2-nsec injection-current pulse produced with a ferrite surge line. The duration of individual regions of the induced laser pulse was about 2×10^{-10} sec. The pulse waveform is illustrated. V.Z.

A67-22660
DESTRUCTION OF TRANSPARENT MATERIALS BY LASER RADIATION - FORMATION OF GAS BUBBLES AND WEDGING OF THE MATERIAL BY GAS PRESSURE.
G. I. Barenblatt, N. N. Vsevolodov, L. I. Mirkin, N. F. Pilipetskii and Iu. P. Raizer (Akademiia Nauk SSSR, Institut Problem Mekhaniki, Moscow, USSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, Feb. 1, 1967, p. 85-87.)
JETP Letters, vol. 5, Feb. 1, 1967, p. 69-71. 10 refs. Translation.
Results of a photographic study of the damage produced by focused laser radiation in polymethylmethacrylate and polystyrene materials. High-speed photographs reveal the formation of high-temperature and high-pressure centers in the form of gas bubbles which produce cracks and wedging of the material as they expand. It is assumed that the damage mechanism involves (1) development of dynamic stresses in the light channel region - caused by heat and possibly by hypersound - followed by the development of minute shear defects in the planes of the maximum tangential stress inclined at ~45° to the beam axis, (2) absorption of light in inhomogeneities thus produced which leads to vaporization and partial burning of the material and consequently to gas bubble evolution, and (3) development of large stresses and cracks under bubble gas pressure. V.Z.

A67-22663 #

SEMICONDUCTOR LASER MODES [MODEN IN EINEM HALBLEITERLASER].

Konrad Unger (Leipzig, Universität, Physikalisches Institut, Leipzig, East Germany).

Annalen der Physik, vol. 19, no. 1-2, 1967, p. 64-75. 24 refs. In German.

Derivation and solution of a wave equation to obtain a steady absorption coefficient for a laser diode. Losses and the coefficients of expansion for all the contained modes are given in the form of closed equations. The first mode is calculated taking into account the photoconductivity and both the near field and the far field. Losses are found to be higher in modes with an electrical vector vertical to the p-n junction than in modes with a vector parallel to the junction. Conventional methods of determining losses in modes of a semiconductor laser are discussed and the results obtained are corrected. V.Z.

A67-22665 #

DESIGN CHARACTERISTICS AND OPERATION OF A CONTINUOUS NEODYMIUM LASER [CARATTERISTICHE DI COSTRUZIONE E FUNZIONAMENTO DI UN LASER A NEODIMIO IN CONTINUA].

M. Manfredi, C. A. Sacchi, G. Soncini, and O. Svelto (Milano Politecnico, Instituto di Fisica, Sezione del GNEQP, Milan, Italy).

Alta Frequenza, vol. 36, Jan. 1967, p. 52-55. 10 refs. In Italian. Research supported by the Consiglio Nazionale delle Ricerche.

Description of the principal design characteristics and operation of a continuous neodymium laser. The laser uses as active material a bar of Nd^{3+} in YAG, pumped in an elliptic cavity by a tungsten filament lamp. Both the bar and the cavity are cooled by water circulating at ambient temperature. The threshold electric power was found to be 450 watts. The results of a series of measurements and experimental findings are described. M.M.

A67-22675

HIGH-POWER LASERS - THEIR PERFORMANCE, LIMITATIONS, AND FUTURE.

F. P. Burns (Korad Corp., Santa Monica, Calif.).

(Institute of Electrical and Electronics Engineers, International Communications Conference, Philadelphia, Pa., June 15-17, 1966, Paper.)
IEEE Spectrum, vol. 4, Mar. 1967, p. 115-120. 12 refs.

Review of what is known about lasers operating in the power range from hundreds of megawatts to several gigawatts. Q switching (passive and active, mechanical and electronic) and the advantages and disadvantages of liquid cells for passive Q switching are discussed. Graphs are given concerning the expected life of ruby crystals. Mention is made of the relationship between luminance and beam angle. Methods for improving the beam angle are also discussed. R.B.S.

A67-22699

LASER OSCILLATION ON HYPERFINE TRANSITIONS IN IONIZED IODINE.

C. S. Willett and O. S. Heavens (York, University, Dept. of Physics, York, England).

Optica Acta, vol. 14, Apr. 1967, p. 195-197. 6 refs.

Summary of simultaneous oscillation on several hyperfine transitions in ionized iodine, by laser beam. Eight transitions are given with corresponding wavelength. The use of the prism wavelength selection technique for suppressing transitions competing for upper level population resulted in no further hyperfine transitions, but enabled laser oscillation at 606.9 nm, previously unreported, to be obtained. R.B.S.

A67-22700

MULTIPLE RECORDING OF HOLOGRAMS.

M. Marchant and D. Knight (Ministry of Aviation, Royal Aircraft Establishment, Farnborough, Hants., England).

Optica Acta, vol. 14, Apr. 1967, p. 199-201. 6 refs.

Brief outline of a method for recording a number of alphanumeric characters on a small area of a relatively coarse, but fast, photographic plate. A diagram of the apparatus is included. The source used is a 1/4 mw helium-neon laser and the object letters are transparent on an opaque background. Multiple recordings can be made either by varying the angle of the reference beam, and hence the spatial frequency of the carrier fringes, or by changing their orientation on the plate. Also treated are the superimposing and reconstruction of up to eight holograms of larger and more complex objects on the emulsion, including ordinary "tonal" transparencies. R.B.S.

A67-22709

TWO-BEAM INTERFEROMETER USING A LASER.

U. Grigull and H. Rottenkolber (München, Technische Hochschule, Institut für technische Thermodynamik, Munich, West Germany).

Optical Society of America, Journal, vol. 57, Feb. 1967, p. 149-155. 27 refs.

Description of two laser interferometers: the Mach-Zehnder type and the Michelson type. In the Mach-Zehnder interferometer, the test beam passes through the test object only once; in the Michelson instrument, the test beam passes through the test object twice, in which case the test object can be a reflecting surface. An advantage of the second type is the large field of view that can be realized with a spherical mirror. A prototype interferometer based on Michelson's principles is described; it consists of two separated units designed to be free of vibrations. The instrument is portable, and experience has shown it to operate well under adverse conditions. Typical results from thermal systems and surface-finish measurement are given. R.B.S.

A67-22713

LASER-BEAM SCINTILLATION IN THE ATMOSPHERE.

D. L. Fried and J. B. Seidman (North American Aviation, Inc., Autonetics Div., Electro-Optical Laboratory, Anaheim, Calif.).

Optical Society of America, Journal, vol. 57, Feb. 1967, p. 181-185. 17 refs.

The variance of the log-amplitude of a laser beam is evaluated for a horizontal propagation path through the atmosphere. The treatment is based upon results obtained by Schmeltzer. It is found that the log-amplitude variance can be separated into two factors, one of which is simply the log-amplitude variance of a spherical wave, as derived by Tatarski. The second factor, which contains the dependence upon the size α_0 of the transmitted beam, can be written as a function of $k\alpha_0^2/z$, where k is the wave number and z is the path length. This second factor shows a significant oscillation around $k\alpha_0^2/z = 1$ when the transmitted beam is collimated and starts to roll off strongly for $k\alpha_0^2/z > 1$ when the transmitted beam is focused at a range z. (Author)

A67-22716

INTERNALLY REFLECTED FILAMENTS IN TRIANGULAR LASER DIODES.

I. Ladany (U.S. Naval Research Laboratory, Washington, D.C.).

Optical Society of America, Journal, vol. 57, Feb. 1967, p. 272, 273. 7 refs.

Study of triangular low-filament laser diodes in regard to altering internal reflection to achieve various phase shift phenomena such as the Goos-Hänchen shift. A filament was focused on a monochromator slit and the spectrum was recorded for different values of peak pulse current through the diode. Then the internally reflecting side was coated with an 860-Å thick film of SiO and the spectrum remeasured. In the uncoated case, lasing starts out in a single line. In the coated case it begins as a doublet. At higher currents, the shape of the envelope of the spectrum for the coated diode approaches the Lorentzian, which is expected in the ideal case. Explanation is given for both the doubling effect and the better spectrum envelope. R.B.S.

A67-22740

MEASUREMENT OF RUBY LASER CAVITY LOSSES BY FABRY-PEROT RESONANCE.

D. F. Nelson and K. F. Rodgers (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
Applied Optics, vol. 6, Mar. 1967, p. 421-427. 28 refs.

Determinations of optical loss in unpumped ruby laser crystals from measurements of the transmissivity vs optical path length (as changed by temperature) using an amplitude regulated, single mode, He-Ne laser beam probe are described. Excellent agreement between these measurements and the theory of Dufour and Picca was obtained for a flux-grown ruby using as-grown feedback surfaces. The essentially zero loss per pass β (apart from end reflector losses) deduced from this comparison is in excellent agreement with a previous determination of the loss in this crystal from laser threshold measurements. The reduction of the effective surface roughness by deposition of multilayer zinc sulfide-cryolite reflectors was observed in these experiments. For a high quality, 7.5-cm long, 0.05 wt% Cr_2O_3, 60° orientation ruby rod, β was found to be 0.03 ± 0.03. For a 90° orientation, 2.2-cm long, trumpet-shaped ruby used for continuous operation threshold studies, β was found to be about 0.14. The problems of this type of loss measurement when index of refraction variations are present are discussed, and observations connecting the crystal quality and laser mode characteristics are presented. (Author)

A67-22741
MEASUREMENT OF THE ROOM TEMPERATURE R_1 LINE WIDTH OF FORTY-TWO RUBIES.
Robert A. Benedict, James F. Nester (Perkin-Elmer Corp., Norwalk, Conn.), and Charles M. Kellington (U.S. Army, Electronics Command, Avionics Laboratory, Fort Monmouth, N.J.).
Applied Optics, vol. 6, Mar. 1967, p. 429, 430. 6 refs.
Army-supported research.

Use of a pressure-scanned Fabry-Pérot etalon to measure with accuracy the room temperature R_1 fluorescent line width of 42 ruby laser crystals. In 41 of these rubies the chromium content was nearly the same, and the R_1 line width for all was 5.0 ± 0.3 Å, in agreement with present theories. M.F.

A67-22742
LASER MODE SELECTION BY INTERNAL REFLECTION PRISMS.
L. G. DeShazer (Southern California, University, Dept. of Electrical Engineering and Materials Science, Los Angeles, Calif.) and E. A. Maunders (Hughes Aircraft Co., Aerospace Group, Culver City, Calif.).
Applied Optics, vol. 6, Mar. 1967, p. 431-435.
USAF-supported research.

Internal reflection prisms were used to produce a narrow angular range of high reflectivity within a laser cavity. The selectivity was obtained from the sharp angular variation of internal reflectivity near the critical angle. Angular mode selection of a Nd:glas normal laser was achieved by this critical internal reflection (CIR) technique. Two-dimensional angular mode selection was observed with two orthogonal Lummer-Gehrcke plates within the laser cavity. (Author)

A67-22743
MULTIPLE PASS EFFECTS IN HIGH EFFICIENCY LASER PUMPING CAVITIES.
V. Evtuhov and J. K. Neeland (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.).
Applied Optics, vol. 6, Mar. 1967, p. 437-441. 9 refs.
USAF-supported research.

Some effects connected with multiple passes of pump radiation in laser pump cavities are discussed. These effects include changes in mercury arc lamp operating characteristics, when the lamps are used inside the cavities as pump sources, and unexpectedly low pulse (but not CW) thresholds in double elliptical cavities. It is shown analytically that these effects can, at least in part, be attributed to the shapes of the pump light energy distribution curves after multiple passes through the pump cavities, and to the relative opacities of flash and continuous lamps. (Author)

A67-22749
MULTICOLOR WAVEFRONT RECONSTRUCTION.
A. A. Friesem and R. J. Fedorowicz (Michigan, University, Institute of Science and Technology, Radar and Optics Laboratory, Ann Arbor, Mich.).
Applied Optics, vol. 6, Mar. 1967, p. 529-536. 13 refs.
USAF-sponsored research.

Two and three primary colors derived from a He-Ne gas laser and an argon gas laser were employed in recording and reconstructing holograms. For the tricolor case it is possible to reconstruct a three-dimensional multicolor image which possesses almost all the natural hues of the original object. Each wavelength generates an independent fringe system that is recorded on a photographic plate with a thick emulsion that constitutes a three-dimensional recording medium. In reconstruction, each fringe system diffracts light in a manner satisfying the Bragg relation for a particular reconstructing wavelength. If the reconstruction wavelengths are the same as the original wavelengths used to record the fringe systems, the result is a multicolor reconstruction possessing few or no ghost images. In our experiments, the angle between the object beam and the reference beam was greater than 100°, and the photographic plates were oriented so that the fringe surfaces were approximately perpendicular to the emulsion surface. This minimized the deleterious effects of single-color, ghost image formation and shrinkage during development. Finally, a method of synthesizing multicolor scenes using a multiple-exposure recording with one wavelength and reconstructing with several wavelengths is described. (Author)

A67-22753
LASER VARIABLE OUTPUT COUPLER.
R. L. Byer and V. R. Costich (Spectra-Physics, Inc., Mountain View, Calif.).
Applied Optics, vol. 6, Mar. 1967, p. 578, 579. 7 refs.

Description of a variable output coupler with a transmittance tunable from zero to one. With a variable output coupler the maximum output power for a given laser excitation level and configuration can easily be obtained. The variable output coupler consists of a MacNeille beam splitter plus a retardation plate. It can be used conveniently to measure gain and loss of various laser transitions or to set the cavity or transmitted powers at desired levels. One of the more important uses of the beam splitter could be to couple orthogonal polarizations out of the laser cavity such as those produced in experiments on internal-cavity second-harmonic generation or parametric oscillation. M.F.

A67-22758
EFFECTS OF PHONON LIFETIME ON STIMULATED OPTICAL SCATTERING IN GASES.
E. E. Hagenlocker, R. W. Minck, and W. G. Rado (Ford Motor Co., Scientific Laboratory, Dearborn, Mich.).
Physical Review, 2nd Series, vol. 154, Feb. 10, 1967, p. 226-233. 20 refs.

The effects of transient conditions on stimulated Brillouin and Raman scattering have been investigated by varying the lifetime of the scattered phonon over four orders of magnitude. The Stokes gain coefficients calculated from our experimental data are as much as several orders of magnitude less than those predicted using steady-state theory, but they are in excellent quantitative agreement
U.S. National Geodetic Satellite Program are briefly discussed.
The main categories of effort concerning laser use are: (1) development of an autotrack capability so that problems of tracking in daylight can be solved, (2) development of a simplified mobile laser ground station for use in position location, and (3) development of CW laser tracking systems using phase modulation techniques.

A67-22824 #
SEMICONDUCTOR LIGHT EMITTERS.
F. Joseph Reid (Battelle Memorial Institute, Columbus, Ohio).
Battelle Technical Review, vol. 16, Mar. 1967, p. 3-9. 20 refs.

Discussion of some of the advantages and disadvantages relating to semiconductor light emitters, with particular emphasis on material characteristics. By choosing a material on the basis of its intrinsic properties and developing less familiar materials, discrete outputs can be achieved in a broad spectral range from about 0.3 to

20 μ. Current efforts to improve these semiconductor lasers through materials-oriented research are discussed. It is pointed out that, because of their small size and simplicity, semiconductor lasers are well suited for intracomputer information transfer, satellite communications, and other electronic applications. M.F.

A67-22835
MODE DISCRIMINATION OF LASER RESONATOR EXPLOITING THE TRANSMISSION CHARACTERISTICS OF THE FABRY-PEROT INTERFEROMETER.
Nobuaki Kumagai and Masanori Matsuhara (Osaka University, School of Engineering, Osaka, Japan).
Electronics and Communications in Japan, vol. 49, Feb. 1966, p. 53-58. Translation.

Theoretical analysis of mode discrimination in a laser cavity in which a Fabry-Pérot interferometer is inserted at a slight angle. The discrimination is accomplished by the sharp frequency dependence of the transmission characteristics of the interferometer. It is shown that an effective mode discrimination is possible using this technique; also, some pertinent factors to be considered in the design of the discriminator are indicated. B.B.

A67-22846
LONGITUDINAL MODES OF A CO_2 LASER CAVITY - APPLICATIONS [MODES LONGITUDINAUX D'UNE CAVITE LASER A CO_2 - APPLICATIONS].
Colette Rosetti, Claude Meyer, Pierre Pinson, and Pierre Barchewitz (Paris, Université, Laboratoire d'Infrarouge, Chimie Physique, Orsay, Seine-et-Oise, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 6, Feb. 6, 1967, p. 452, 453. 5 refs. In French.

Observation of the longitudinal modes of a CO_2 laser cavity by varying the optical length of the cavity. In this case the optical length is varied either by slowly displacing one of the mirrors or by slowly varying the gas pressure. As an application, the laser emission is modulated by a piezoelectric quartz crystal, and the refractive index of CO_2 in the $00^01\text{-}10^00$ transition is determined. A.B.K.

A67-22854
MOLECULAR ELECTRONIC EXCITATION BY ULTRAVIOLET LASERS - APPLICATION TO FLASH SPECTROSCOPY [EXCITATION ELECTRONIQUE MOLECULAIRE PAR LASER ULTRAVIOLET - APPLICATION A LA SPECTROSCOPIE PAR ECLAIR].
Jean-René Lalanne (Centre National de la Recherche Scientifique, Institut de Magnétochimie, Pessac, Gironde, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 7, Feb. 13, 1967, p. 526-529. 14 refs. In French.

Description of a flash-spectroscopy apparatus in which the molecules are excited by an ultraviolet flash produced by a Q-switched ruby laser after frequency doubling. It is shown that with the aid of this device a large number of molecules (10^{-4} molecules per lambert in the case of acridine) can be brought to the lowest-energy triplet state. A.B.K.

A67-22855
THEORY OF THE RAMAN SPECTRUM OF A CRYSTAL EXCITED BY A LASER [THEORIE DU SPECTRE RAMAN D'UN CRISTAL EXCITE PAR UN LASER].
Gérard-William Cohen-Solal (Montpellier, Université, Service de Physique Théorique, Montpellier, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 7, Feb. 13, 1967, p. 537-539. 5 refs. In French.

Development of a theory of the spectrum of second-order Raman lines in the coupling of radiation and matter. The formalism of causal Green's functions is used to calculate the effective collision cross sections. The proposed theory is applied to the Raman effect of crystals of diamond-like structure, a good agreement being found with experimental results. It is noted that this line spectrum is superimposed on the second-order continuous spectrum. A.B.K.

A67-22860
THE DIADEME SATELLITES (D-1C AND D-1D).
La Recherche Spatiale, vol. 6, Feb. 1967, p. 1-16. In French.

Discussion of the modification of the Diadème satellites D-1C and D-1D. A detailed description of these two identical satellites is given. To permit range determinations, the satellite is coated with cat's-eye reflectors capable of returning laser light beams to their point of origin on the ground. Topics discussed include structure, stabilization, solar detectors for the determination of the altitude, energy on board the satellite, telemetry, reflectors, and thermal control. The scientific program of these satellites includes spatial geodesy, measurements by the Doppler effect, and laser telemetry. M.F.

A67-22866 #
QUANTUM MECHANICAL DESCRIPTION OF THE INTERFERENCE BETWEEN INDEPENDENT NONMONOCHROMATIC LIGHT BEAMS [QUANTENMECHANISCHE BESCHREIBUNG DER INTERFERENZ ZWISCHEN UNABHÄNGIGEN NICHTMONOCHROMATISCHEN LICHTSTRAHLEN].
H. Paul (Deutsche Akademie der Wissenschaften, Institut für spezielle Probleme der theoretischen Physik, Berlin, East Germany).
Annalen der Physik, vol. 19, no. 3-4, 1967, p. 210-215. 12 refs. In German.

The concept of nonmonochromatic modes of the radiation field introduced recently by Titulaer and Glauber is employed to give a quantum mechanical description of the interference between nonmonochromatic light beams produced by different sources (e.g. lasers). The result is, in fact, that previous calculations by the author et al. in which each light beam was idealized as an excited state of one monochromatic mode, practically unchanged apply also to nonmonochromatic modes. The previous formulae describing the interference, on the other hand, are reproduced for the special case of (nonmonochromatic) modes corresponding to finitely extended beams of plane wave type, and, thus, are founded more exactly. (Author)

A67-22881
LASER RANGE-FINDING - STUDY OF THE LIMITING RANGE.
Claude Véret.
La Recherche Aérospatiale, Jan.-Feb. 1967, p. 51-56. In French.

Study of the limiting range of a laser range-finder designed for the trajectography of mobiles such as rockets, balloons or satellites. The effect of the various parameters related to the source, the receiver, the nature of the surface covering the mobile, the atmosphere, and the luminosity of the background around the object are examined by means of an example. M.F.

A67-22891
QUANTUM MECHANICAL THEORY OF FLUCTUATIONS AND RELAXATION IN SEMICONDUCTOR LASERS.
H. Haug (Stuttgart, Technische Hochschule, I. Institut für theoretische Physik, Stuttgart, West Germany).
Zeitschrift für Physik, vol. 200, no. 1, 1967, p. 57-68. 13 refs.
Research supported by the Deutsche Forschungsgemeinschaft.

Pumping, spontaneous emission and electron-electron scattering lead to relaxation terms in the mean equations of motion for the electron system. These terms are derived from a quantum mechanical basis by second order perturbation theory and by appropriate reservoir averaging. If the electron distribution is not too strongly degenerate, then a relaxation time approximation can be derived. The quantum mechanical Langevin method is used to include noise. The correlation functions of all fluctuation operators are calculated. From the knowledge of the equations of motion and of the correlation functions it is possible to calculate the noise properties of the laser light and of the junction current, as will be shown in other publications. (Author)

A67-22893
CALCULATION AND EXPERIMENTAL COMPARISON OF THE AMPLIFICATION FACTORS FOR A 6328 Å LASER TRANSITION IN A He-Ne DISCHARGE [BERECHNUNG UND EXPERIMENTELLER VERGLEICH DES VERSTÄRKUNGSFAKTORS FÜR DEN LASER-ÜBERGANG 6328 Å IN EINER He-Ne GASENTLADUNG].
G. Herziger, W. Holzapfel, and W. Seelig (Berlin, Technische Universität, I. Physikalisches Institut, Berlin, West Germany).
Zeitschrift für Physik, vol. 200, no. 1, 1967, p. 103-116. 18 refs. In German.
Research supported by the Stiftung Volkswagenwerk.

Solution of rate equations for the density of excited atoms in a He-Ne discharge for the steady-state. The atomistic parameters in the theoretical treatment are replaced by experimental values, hence inversion density and single pass gain can be calculated as a function of gas mixture, pressure, discharge, current, and the geometry of the discharge tube. Conditions for the maximum inversion density and single pass gain are calculated and compared with experimentally determined values. Good agreement is found for the maximum single pass gain and the related values of discharge current, gas mixture, and pressure. B.B.

A67-22906 *
SINGLE-FREQUENCY LIGHT FROM AN ARGON FM LASER.
L. M. Osterink (Stanford University, School of Engineering, Dept. of Electrical Engineering, Stanford, Calif.) and Russell Targ (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Electronic Defense Laboratories, Mountain View, Calif.).
Applied Physics Letters, vol. 10, Feb. 15, 1967, p. 115-117. 6 refs.
Grant No. NGR-05-020-103; Contract No. NAS 8-20558.

Description of an experiment in which 350 Mw of single-frequency light at 5145 Å was obtained using an argon FM laser with an external $LiNbO_3$ modulator. Data on overall conversion efficiency from multifrequency to single-frequency light are given, and the reduction in distortion with increasing optical power is discussed. Total sideband content is found to be less than 0.125% of the maximum optical power, corresponding to an arc ripple of 3.5% rms. B.B.

A67-22909
MEASUREMENT OF PHOTON ABSORPTION LOSS IN THE ACTIVE AND PASSIVE REGIONS OF A SEMICONDUCTOR LASER.
R. Hunsperger and J. Ballantyne (Cornell University, Dept. of Applied Physics, Ithaca, N.Y.).
Applied Physics Letters, vol. 10, Feb. 15, 1967, p. 130-132. 8 refs.
Research supported by Cornell University and the U.S. Army.

A technique is described for measuring the photon absorption coefficients in the active and passive regions of an electron-beam-pumped semiconductor laser. Measurements made at 4°K on n-type, single-crystal GaAs indicate that photon loss in the active region is due to free carrier absorption, and that this absorption coefficient increases linearly from 2.5 cm^{-1} to 47 cm^{-1} as donor concentration is varied from 2.4×10^{17} cm^{-3} to 4.7×10^{18} cm^{-3}. For each case the active region absorption coefficient is less than that measured in the passive region, which varies from 354 cm^{-1} to 98 cm^{-1} over the same range of donor concentrations. The increased loss in the passive region is attributed to interband absorptive transitions. (Author)

A67-23008
ELECTRON AND LASER BEAM WELDING - TO DATE AND 1970.
Kenneth J. Miller (Metals Joining Corp., Redondo Beach, Calif.).
Annual Western Metal and Tool Conference and Exposition, 4th, Los Angeles, Calif., Mar. 13-17, 1967, Paper WES 7-54. 15 p.

Description of the functions and operation of the laser system with respect to its use as a welding and metal-removing tool. The tungsten inert gas (TIG) arc welding process, which can join most metals and produce little or no oxidation while they are in a molten state, is discussed, and laser welding and electron beam welding techniques are compared. B.B.

A67-23068 #
LASERS BASED ON SOLUTIONS OF RARE-EARTH CHELATES [OPTICHESKIE KVANTOVYE GENERATORY NA RASTVORAKH RED-KOZEMEL'NYKH KHELATOV].
L. D. Derkacheva, G. V. Peregudov, and A. I. Sokolovskaia (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Uspekhi Fizicheskikh Nauk, vol. 91, Feb. 1967, p. 247-260. 32 refs. In Russian.

Brief description of the properties and special features of laser generation using solutions of rare-earth chelates. The spectral properties of rare-earth chelates are summarized, and certain features of chelates as laser materials are noted. The requirements that must be satisfied by the working solution of a laser are reviewed, and the apparatus used for laser generation with the aid of chelate solutions is described. The results of studies of the properties of laser emission generated with the aid of Eu(BA) solutions are cited. A.B.K.

A67-23069
DEVELOPMENTS IN LASER COMMUNICATIONS.
Henry R. Senf (Hughes Aircraft Co., Research Laboratories, Quantum Electronics Section, Malibu, Calif.).
Signal, vol. 21, Mar. 1967, p. 12, 14, 15, 18-21. 7 refs.

General survey of laser progress - including the fundamental physics of lasers, research and development of the system components, atmospheric propagation studies, deep-space communication system studies, and the development of experimental communications. Estimated designs for two laser communication systems predicted for use in 1975 are outlined. The greatest hope for the future of laser communications, both for atmospheric and space paths, appears to be at 10.6 μ with the high-power, high-efficiency CO_2 laser. R.B.S.

A67-23070
LASER IN UNIFORM - TODAY'S BEACON - TOMORROW'S MILITARY COMMUNICATIONS-ELECTRONICS.
William B. Latta (U.S. Army, Electronics Command, Fort Monmouth, N.J.).
Signal, vol. 21, Mar. 1967, p. 22-24, 27, 28, 30.

General review of laser use in the Army. Certain characteristics of lasers that are especially suitable for precision measurement, position-fixing and target location, for illumination to enable the army to operate more nearly at maximum efficiency at night, and for creating a signal source useful for secure communication are discussed. Optically pumped lasers, gas lasers, and semiconductor injection lasers are briefly reviewed. R.B.S.

A67-23071 *
LASER TECHNOLOGY FOR TRACKING AND GEODESY.
Leonard Jaffe (NASA, Office of Space Science and Applications, Washington, D.C.).
Signal, vol. 21, Mar. 1967, p. 32-35, 72.

General survey concerning the use of lasers for tracking and geometric geodesy. Laser ranging systems used in Explorer and Geos satellite missions are mentioned. Various projects of the U.S. National Geodetic Satellite Program are briefly discussed. The main categories of effort concerning laser use are: (1) development of an autotrack capability so that problems of tracking in daylight can be solved, (2) development of a simplified mobile laser ground station for use in position location, and (3) development of CW laser tracking systems using phase modulation techniques. Single-mode neodymium-glass lasers, having radiated as much as 50 joules into a single diffraction-limited sharp pulse, are mentioned as radiation sources for optical radar systems, as an alternative to the ruby laser. R.B.S.

A67-23072
HOLOGRAPHY - RECORDING LIGHT IN THREE DIMENSIONS.
Bruce Shore (Radio Corporation of America, RCA Laboratories, Princeton, N.J.).
Signal, vol. 21, Mar. 1967, p. 36-38.

Brief review of three-dimensional photography, including color photography, based upon the laser-derived hologram. Particularly examined is the split-beam technique, which, when combined with the phenomena of optical interference, lends itself to the production of the three-dimensional photographs. Historical predecessors to the hologram, such as the Fresnel zone plate, are noted. R.B.S.

A67-23102

GENERATION IN MIXED CdS_x-$CdSe_{1-x}$ CRYSTALS EXCITED WITH RUBY LASER RADIATION.

M. S. Brodin, N. I. Vitrikhovskii, S. V. Zakrevskii, and V. Ia. Reznichenko (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki and Institut Poluprovodnikov, Kiev, Ukrainian SSR).

(Fizika Tverdogo Tela, vol. 8, Oct. 1966, p. 3084-3086.)

Soviet Physics - Solid State, vol. 8, Apr. 1967, p. 2461-2463. 9 refs. Translation.

[For abstract see issue 03, page 436, Accession no. A67-13153]

A67-23182 *

SATELLITE RANGE MEASUREMENTS WITH A LASER AT AN ASTROPHYSICAL OBSERVING STATION.

C. G. Lehr, L. A. Maestre, and P. H. Anderson (Smithsonian Institution, Smithsonian Astrophysical Observatory, Cambridge, Mass.).

(COSPAR, International Space Science Symposium, 7th, Vienna, Austria, May 10-18, 1966, Paper.)

IN: SPACE RESEARCH VII; PROCEEDINGS OF THE SEVENTH INTERNATIONAL SPACE SCIENCE SYMPOSIUM, VIENNA, AUSTRIA, MAY 10-18, 1966. VOLUME 2. [A67-23176 10-13]

Symposium sponsored by the Committee on Space Research, the International Union of Geodesy and Geophysics, and the International Scientific Radio Union.

Edited by R. L. Smith-Rose.

Amsterdam, North-Holland Publishing Co., 1967, p. 723-734. 12 refs.

Grant No. NsG-87-60.

[For abstract see issue 15, page 2453, Accession no. A66-29998]

A67-23328

HAZARDS OF LASER RADIATION - MECHANISMS, CONTROL AND MANAGEMENT.

Martin S. Litwin (U.S. Veterans Administration Hospital, West Roxbury; Northeastern University; Harvard University, Harvard Medical School, Boston, Mass.), Samuel Fine, Harold Raemer (Northeastern University, Boston, Mass.), Edmund Klein (Roswell Park Memorial Institute, Buffalo, N.Y.), and Ben S. Fine (U.S. Armed Forces Institute of Pathology; George Washington University, Washington, D.C.).

American Industrial Hygiene Association, Journal, vol. 28, Jan.-Feb. 1967, p. 68-75. 10 refs.

U.S. Public Health Service Grant No. RH 00361-01-RAD; Contracts No. DA-49-193-MD-2436; No. DA-49-193-MD-2437; No. DA-49-193-MD-2680; No. AF 29(600)-5136.

Analysis of biological studies indicates the factors responsible for hazards associated with laser systems: (1) the laser radiation and its interaction with the biological system, (2) the pumping source, (3) the high voltage and current required for operation of a laser system and, (4) the environment in which this system is used. Short-term and long-term hazards associated with the beam are dependent on the properties of the radiation and those of the biological system. Hazards associated with flashtubes must be considered, particularly since misfire or accidental firing can occur. Long-term effects on the eyes due to either a single insult or to cumulative subthreshold insults are not yet known but continue to present a potential hazard. Hazards to the skin must also not be neglected in continued testing. (Author)

A67-23332

NONSTATIONARY SELF-FOCUSING OF LASER PULSES IN A DISSIPATIVE MEDIUM.

S. A. Akhmanov and A. P. Sukhorukov (Moskovskii Gosudarstvennyi Universitet, Fizicheskii Fakul'tet, Moscow, USSR).

(ZHETF Pis'ma v Redaktsiiu, vol. 5, Feb. 15, 1967, p. 108-113.)

JETP Letters, vol. 5, Feb. 15, 1967, p. 87-91. 13 refs. Translation.

Discussion of the influence of relaxation processes in a nonlinear medium on the dynamics of self-focusing of laser pulses, without assuming that the nonlinear response of the medium follows the field quasi-statically. A procedure is developed whereby it is possible to analyze temporal nonlinear aberrations connected with thermal effects; these aberrations are quite appreciable in the case of giant pulses. M.F.

A67-23333

CURRENTS PRODUCED BY LIGHT PRESSURE WHEN A LASER BEAM ACTS ON MATTER.

G. A. Askar'ian, M. S. Rabinovich, A. D. Smirnova, and V. B. Studenov.

(ZHETF Pis'ma v Redaktsiiu, vol. 5, Feb. 15, 1967, p. 116-118.)

JETP Letters, vol. 5, Feb. 15, 1967, p. 93-95. Translation.

Experimental investigation of the currents produced by light pressure on the surface of a metal and in the plasma of the flare produced when a laser beam acts on a surface. An ordinary ruby laser which was Q-switched by a rotating prism was used. The laser beam was focused onto the surface of a small target which could be turned to any angle relative to the beam axis. A laser mode was used in which two light pulses were produced in sequence, making it possible to investigate effects due to the action of light on the plasma or on the gas in the flare produced by the light of the first pulse. The appearance of currents in the plasma under the influence of light is similar to the appearance of a magnetic moment of a spark in the focus of the laser, recently observed by Korobkin et al. and called the "Korobkin effect." In this case, the plasma was produced in the target by the flare, and this may be why no strong change was observed in the direction of the moment as the beam moved away from the lens axis. M.F.

A67-23335

INFLUENCE OF RATE OF DISINTEGRATION OF THE LOWER LASER LEVEL ON THE POWER OF A CO_2 LASER.

N. N. Sobolev and V. V. Sokovikov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).

(ZHETF Pis'ma v Redaktsiiu, vol. 5, Feb. 15, 1967, p. 122-125.)

JETP Letters, vol. 5, Feb. 15, 1967, p. 99-101. 14 refs. Translation.

Examination of the influence of the relaxation rate of the lower laser level on the magnitude of the inverse population, and by the same token, on the generation power of a CO_2 laser. It is concluded that absolutely pure undissociated CO_2 cannot provide appreciable generation power, for in this case the power is limited by the slow rate of disintegration of the lower laser level. Usually insufficiently pure commercial grades of CO_2 are used in lasers. On the other hand, the presence of certain impurities is not only harmless but on the contrary is useful. To obtain very high powers, the presence of impurities in the CO_2 is obligatory - i.e., they must either be introduced into the laser tube or must result from the dissociation of the CO_2. M.F.

A67-23382

MEASUREMENTS OF ELECTRON IMPACT EXCITATION CROSS SECTIONS OF LASER STATES OF ARGON(II).

J. M. Hammer and C. P. Wen (Radio Corporation of America, RCA Laboratories, Princeton, N.J.).

Journal of Chemical Physics, vol. 46, Feb. 15, 1967, p. 1225-1230. 26 refs.

Cross sections for the excitation of the upper laser levels $4p\,^2D_{5/2}$, $^2D_{3/2}$, $^2P_{3/2}$, and $^2S_{1/2}$ of Ar(II) by electron impact with ground-state neutral atoms have been found by measuring the incoherent light produced by a triode-type structure filled with argon to pressures near 0.1 torr. Peak values in the vicinity of 5×10^{-19} cm^2 are found. By operating the same structure in an argon-ion laser cavity, an increase in coherent output is measured. The amount of the increase in output may be used in conjunction with the measured upper-state cross section to estimate the cross section for electron excitation of the lower laser levels. (Author)

A67-23415
SHUTTER SYSTEM REDUCES LASER HAZARDS.
Norman Koch (Bissett-Berman Corp., Santa Monica, Calif.).
Microwaves, vol. 6, Mar. 1967, p. 129, 130.

Description of a simple arrangement of lenses and a camera shutter which allows permanent or temporary variation of observation time and of the laser beam diameter without disturbing the overall experimental arrangement. The system consists of a short focal length lens, a longer focal length lens, and a removable camera shutter. Exposure of personnel during the experiment is minimized by selecting a suitably fast shutter speed. F.R.L.

A67-23441 *
OPERATIONAL PERFORMANCE OF AN H-BAND COUPLED CAVITY TRANSMISSION MASER.
C. T. Stelzried (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.).
Microwave Journal, vol. 10, Mar. 1967, p. 103-106. 7 refs.

Evaluation of the performance of the Hughes 8448-MHz maser amplifier by measuring its bandwidth, gain and gain stability, input matching, and low noise temperature operation. The liquid-helium Dewar time, noise temperature, bandwidth gain, and stability characteristics of the device are found to be satisfactory for experimental field uses. The use of this maser as a preamplifier in experimental low-noise receiving communications systems and in radar/radio astronomy is mentioned. V.Z.

A67-23505
INTERNAL NOISE TEMPERATURE OF A REFLECTION MASER [DIE INNERE RAUSCHTEMPERATUR DES REFLEXIONSMASERS].
K. Rupf (Karlsruhe, Technische Hochschule, Institut für Hochfrequenztechnik und Hochfrequenzphysik, Karlsruhe, West Germany)
Zeitschrift für angewandte Physik, vol. 22, no. 4, 1967, p. 312-317. 8 refs. In German.
Research supported by the Deutsche Forschungsgemeinschaft.

Determination of the intrinsic noise temperature of a ruby maser as a function of helium bath temperature and Cr_2O_2 doping of the ruby rods. The maser was immersed in a bath of liquid helium together with a low-temperature circulator and the comparison noise sources (consisting of absorbers in separate helium baths with different temperatures). The lowest noise temperature of $0.55 \pm 0.14^{\circ}K$ was achieved with ruby single crystals containing 0.045% of Cr_2O_3, at a temperature of $1.56^{\circ}K$. The measured values were found to be in good agreement with the noise temperature computed on the basis of the noise wave concept. M.M.

A67-23518 #
NEW ASPECTS OF SOLUTION REGROWTH IN THE DEVICE TECHNOLOGY OF GALLIUM ARSENIDE.
H. Rupprecht (International Business Machines Corp., Thomas J. Watson Research Center, Yorktown Heights, N.Y.).
IN: GALLIUM ARSENIDE; PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM, READING, BERKS., ENGLAND, SEPTEMBER 26-28, 1966. [A67-23509 10-09]
Symposium sponsored by the Institute of Physics, the Physical Society, and the Systems Command of the U.S. Air Force.
Edited by A. C. Stickland.
London, Institute of Physics; Physical Society (Institute of Physics and Physical Society Conference Series No. 3), 1967, p. 57-61; Discussion, H. Beneking (Aachen, Technische Hochschule, Institut für Halbleitertechnik, Aachen, West Germany), N. N. Winogradoff (National Bureau of Standards, Washington, D.C.), E. W. Williams (Texas Instruments, Inc., Dallas, Tex.), and G. H. Winstel (Siemens AG, Munich, West Germany), p. 85, 86. 11 refs.
Army-supported research.

Discussion of recent contributions to the technology of electroluminescent devices made by solution regrowth. Threshold current densities in GaAs injection lasers, normally above 10^5 amp/cm^2 at $300^{\circ}K$ for single-step diffused junctions, have been markedly reduced by this method. Values as low as 26,000 amp/cm^2 have been observed. It is shown that solution regrowth can be adapted to a planar technology, and fabrication procedures for planar laser structures are described. A novel concept of light-emitting diodes is described, using some unique features of solution regrowth in combination with the amphoteric behavior of silicon in gallium arsenide. An interesting feature of these diodes is their external quantum efficiency at $300^{\circ}K$. M.M.

A67-23519 #
A THEORY OF THE HIGH POWER OPERATION OF GALLIUM ARSENIDE LASERS.
C. H. Gooch (Ministry of Defence /Navy/, Services Electronics Research Laboratory, Baldock, Herts., England).
IN: GALLIUM ARSENIDE; PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM, READING, BERKS., ENGLAND, SEPTEMBER 26-28, 1966. [A67-23509 10-09]
Symposium sponsored by the Institute of Physics, the Physical Society, and the Systems Command of the U.S. Air Force.
Edited by A. C. Stickland.
London, Institute of Physics; Physical Society (Institute of Physics and Physical Society Conference Series No. 3), 1967, p. 62-67.

A theory of the high power operation of a semiconductor laser is presented. Above threshold it is assumed that all the injected electrons are stimulated to give photons traveling in either of two opposite directions in the junction plane. The number stimulated in either direction is proportional to the number traveling in that direction. It is also assumed that losses occur, and we characterize these by an absorption coefficient a, values of which have been reported by other workers. These concepts result in a differential equation the solution of which predicts the field distribution along the junction and the output from the device. Numerical solutions of this equation have been computed taking the laser cavity length, reflectivity and absorption as variable parameters. These results predict efficiencies which are in reasonable agreement with observed values. It has recently been reported that damage can occur in laser junctions and it is suggested that this is due to the high optical flux which exists in the junction region. The theory enables this flux density to be calculated, and the results obtained are compared with the conditions required to produce damage in lasers of various sizes. (Author)

A67-23520 #
THE SURFACE DAMAGE OF HIGH OUTPUT GALLIUM ARSENIDE LASERS.
C. D. Dobson and F. S. Keeble (International Telephone and Telegraph Corp., Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England).
IN: GALLIUM ARSENIDE; PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM, READING, BERKS., ENGLAND, SEPTEMBER 26-28, 1966. [A67-23509 10-09]
Symposium sponsored by the Institute of Physics, the Physical Society, and the Systems Command of the U.S. Air Force.
Edited by A. C. Stickland.
London, Institute of Physics; Physical Society (Institute of Physics and Physical Society Conference Series No. 3), 1967, p. 68-71; Discussion, N. N. Winogradoff (National Bureau of Standards, Washington, D.C.), J. B. Gunn (International Business Machines Corp., New York, N.Y.), and P. C. Newman (Plessey Co., Ltd., Ilford, Essex, England), p. 86, 87.

It has been found that the maximum power output from a gallium arsenide laser is limited reversibly by thermal heating and irreversibly by a surface damage phenomenon. Examination of damaged lasers has revealed damage on the p side of the junction in the form of narrow channels, about 2 μ wide and 10 to 20 μ long. Globules are found, spaced intermittently along the channels; an examination of the damage by electron probe analysis shows the globules to be a gallium-rich phase. The damage mechanism appears to be in the form of surface junction heating which eventually drives off arsenic vapor and allows a gallium-rich globule to form resulting in the destruction of that part of the Fabry-Pérot cavity. The surface heating appears to be caused by absorption of laser radiation by inhomogeneities. Devices which run satisfactorily at higher ambient temperatures and high current densities are destroyed when the output power is increased by reducing the temperature. The resistance of lasers to surface damage is critically dependent upon the material from which the device is made. Methods of avoiding surface damage are discussed and a new "troughed laser" construction described.

The "trough laser" considerably reduces surface damage and allows operation at 130-watts peak power. (Author)

A67-23521 #
GALLIUM ARSENIDE LASERS - POWERFUL LIGHT SOURCES.
J. L. Fertin, J. Lebailly, J. Thillays, and J. C. Dubois [La Radiotechnique, S.A., Caen, France).
IN: GALLIUM ARSENIDE; PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM, READING, BERKS., ENGLAND, SEPTEMBER 26-28, 1966. [A67-23509 10-09]
Symposium sponsored by the Institute of Physics, the Physical Society, and the Systems Command of the U.S. Air Force.
Edited by A. C. Stickland.
London, Institute of Physics; Physical Society (Institute of Physics and Physical Society Conference Series No. 3), 1967, p. 72-77.
8 refs.

Description of the properties of GaAs laser diodes working in pulse operation at liquid nitrogen temperature. The lasers are made by zinc diffusion into a tellurium-doped crystal grown by the horizontal Bridgman method. The properties of stimulated emission are described, with emphasis on the analysis of the electromagnetic cavity, namely the parameters which define it. It was found that the total reflection and diffraction losses are slightly less than absorption losses for a rectangular shape of 300 x 1000 μ. A correlation between far field patterns and near field patterns is attempted.
M.M.

A67-23522 #
THE FLOW OF CARRIERS AND ITS EFFECT ON THE SPATIAL DISTRIBUTION OF RADIATION FROM INJECTION LASERS.
A. K. Jonscher and M. H. Boyle (London, University; Chelsea College of Science and Technology, Physics Dept., London, England).
IN: GALLIUM ARSENIDE; PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM, READING, BERKS., ENGLAND, SEPTEMBER 26-28, 1966. [A67-23509 10-09]
Symposium sponsored by the Institute of Physics, the Physical Society, and the Systems Command of the U.S. Air Force.
Edited by A. C. Stickland.
London, Institute of Physics; Physical Society (Institute of Physics and Physical Society Conference Series No. 3), 1967, p. 78-84.
12 refs.

A discussion is given of the distribution of injected carrier densities in strongly forward biased laser junctions. It is pointed out that the reduction of radiative lifetime within the lasing regions should have two effects: an increase of current density and a reduction of the injected carrier densities within these regions. The latter should cause an increase of the refractive index within the lasing region relative to the non-lasing regions. The former should lead to a tendency to filamentary pattern of current flow - i.e., its confinement to limited regions of the junction area. Both effects combine to give an inherent tendency to the formation of lasing filaments and explain their presence in injection lasers. The distribution of radiation in the plane and normal to the plane of the junction has been measured from below threshold up to ten times the threshold current in gallium arsenide lasers at 77°K. The resulting patterns in the junction plane are interpreted in terms of light guiding in filaments and interference between filaments. Normal to the plane, the observed sharp peaks superimposed on a broad envelope are interpreted as being due to oscillatory modes reflected between the highly absorbing n and p regions. (Author)

A67-23565
PULSED ELECTRODELESS DISCHARGE AS A LIGHT SOURCE FOR LASER EXCITATION AND OBSERVATION OF THE CHARACTERISTICS OF LASER OUTPUT.
Zung-Kui Chang and Mow-Foh Yeh (Academia Sinica, Peking, Communist China).
(Acta Physica Sinica, vol. 22, Feb. 1966, p. 174-182.)
Chinese Journal of Physics (Peking), vol. 22, Aug. 1966, p. 139-144.
14 refs. Translation.

A67-23568
SOME THERMAL EFFECTS IN GaAs LASERS.
V. S. Bagaev, Iu. N. Berozashvili, V. S. Ivanov, B. D. Kopylovskii, and Iu. N. Korolev (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Pribory i Tekhnika Eksperimenta, vol. 11, July-Aug. 1966, p. 185-189.)
Instruments and Experimental Techniques, Mar. 1967, p. 964-968.
8 refs. Translation.

A67-23582
HYPERSOUND ABSORPTION IN QUARTZ AND RUBY CRYSTALS.
E. M. Ganapol'skii and A. N. Chernets (Akademiia Nauk Ukrainskoi SSR, Institut Radiofiziki i Elektroniki, Kharkov, Ukrainian SSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, Aug. 1966, p. 383-393.)
Soviet Physics - JETP, vol. 24, Feb. 1967, p. 255-262. 19 refs. Translation.

A67-23584
GIANT PULSE STRUCTURE IN A LASER WITH INSTANTANEOUS Q-SWITCHING.
R. V. Ambartsumian, N. G. Basov, V. S. Zuev, P. G. Kriukov, V. S. Letokhov, and O. B. Shatberashvili (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, Aug. 1966, p. 406-411.)
Soviet Physics - JETP, vol. 24, Feb. 1967, p. 272-275. 16 refs. Translation.

A67-23623
HOLOGRAPHY - RECORDING LIGHT IN THREE DIMENSIONS.
Bruce Shore (Radio Corporation of America, David Sarnoff Research Center, Princeton, N.J.).
Photographic Applications in Science and Technology, vol. 1, Spring 1967, p. 32-35, 51, 52.

Description of the principle of the hologram, a new three-dimensional image-recording technique. It is noted that the ability of holograms to produce standard photographs rests on the fact that they can be made to reconstruct two types of three-dimensional images: one, the so-called virtual image, appears only when one looks through the hologram in the general direction of the read-out laser beam; the other, called the real image, is seen on the other side of the hologram and may be recorded in two dimensions by the simple expedient of inserting a screen or photographic plate in the path of the light. The ability to produce color holograms in three dimensions visible in ordinary light depends on a surprising technique that employs the thickness of the hologram emulsion itself. Red, blue, and green lasers simultaneously illuminate the object to be holographed.
M.M.

A67-23625
PULSED LASER HOLOGRAPHY.
Bruce Ruff (Spectra-Physics, Inc., Mountain View, Calif.).
Optical Spectra, vol. 1, Jan. 1967, p. 48-50. 8 refs.

Consideration of a pulsed ruby laser as a holographic light source by comparing it with the more commonly used He-Ne gas laser. The cost, energy output, coherence, and applications of this facility are discussed, and the restrictions imposed on the quality of the reconstructed image through use of a CW laser are considered.
B.B.

A67-23648 #
EFFECTS OF NONUNIFORM EXCITATION OF SEMICONDUCTOR LASERS PUMPED BY AN ELECTRON [EFFEKTY NEODNORODNOSTI VOZBUZHDENIIA POLUPROVODNIKOVYKH LAZEROV S NAKACHKOI ELEKTRONNYM PUCHKOM].

O. V. Bogdankevich, V. A. Goncharov, B. M. Lavrushin, V. S. Letokhov, and A. F. Suchkov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Fizika i Tekhnika Poluprovodnikov, vol. 1, Jan. 1967, p. 7-14. 12 refs. In Russian.

Analytical determination of the steady-state field distribution (in the near and far zones) of a laser pumped by a fast-electron beam, with allowance for the spatial nonuniformity of excitation density. The generation threshold is calculated as a function of the degree of excitation nonuniformity. The analytical results are compared with data obtained with a GaAs and a GaAs-GaP laser at beam energies from 30 to 150 kev. V.P.

A67-23653 #
THEORY OF LASER EMISSION AT BAND-BAND TRANSITIONS IN AN IMPURITY SEMICONDUCTOR WITHOUT CONSERVATION OF QUASI-MOMENTUM [TEORIIA LAZERNOGO IZLUCHENIIA NA ZONA-ZONNYKH PEREKHODAKH V PRIMESNOM POLYPROVODNIKE PRI NESOKHRANENII KVAZIIMPUL'SA].
V. L. Vinetskii, V. S. Mashkevich, and G. Iu. Buriakovskii (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki, Kiev, Ukrainian SSR).
Fizika i Tekhnika Poluprovodnikov, vol. 1, Jan. 1967, p. 54-62. 13 refs. In Russian.

Development of a theory of laser emission at band-band transitions in an impurity semiconductor, on the basis of the kinetic equations. The case is treated in which the law of conservation of quasi momentum is violated due to the presence of impurities. The analysis is developed for steady-state conditions. The positions of the electron and hole Fermi quasi-levels are determined, together with the value of the pumping threshold. The generation of laser emission is compared for a pure semiconductor and an impurity semiconductor with and without conservation of quasi-momentum. V.P.

A67-23654 #
THEORY OF LASER EMISSION AT INDIRECT TRANSITIONS WITH PARTICIPATION OF THE CURRENT CARRIERS [TEORIIA LAZERNOGO IZLUCHENIIA NEPRIAMYKH PEREKHODAKH S UCHASTIEM NOSITELEI TOKA].
V. S. Mashkevich (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki, Kiev, Ukrainian SSR).
Fizika i Tekhnika Poluprovodnikov, vol. 1, Jan. 1967, p. 63-71. 14 refs. In Russian.

Analytical investigation of the generation of laser radiation at indirect band-band transitions with participation of free carriers in a pure semiconductor. A theory is developed on the basis of the kinetic equations. The frequency of generation, the positions of the hole and electron Fermi quasi-levels, and the pumping threshold are determined. It is shown that for generation parameter values of practical interest, generation at the transitions under study is possible over a wide temperature range. V.P.

A67-23665 #
NATURE OF STIMULATED EMISSION IN GALLIUM-ANTIMONIDE INJECTION LASERS [O PRIRODE STIMULIROVANNOI EMISSII INZHEKTSIONNYKH LAZEROV IZ ANTIMONIDA GALLIIA].
Ia. E. Pokrovskii and K. I. Svistunova (Akademiia Nauk SSSR, Institut Radiotekhniki i Elektroniki, Moscow, USSR).
Fizika i Tekhnika Poluprovodnikov, vol. 1, Jan. 1967, p. 149, 150. 5 refs. In Russian.

Experimental study of the nature of stimulated emission in diode-lasers with steep flat p-n junctions, emittive areas of Zn-doped p-type GaSb, and a GaSb base. A typical dependence of the luminescence intensity on injection current density at 78°K was noted, and the recombination-emission spectral distribution at different injection levels is given for such diodes. V.Z.

A67-23776 #
OPTICAL PROBE ATTENUATION IN CS_2 INDUCED BY A RUBY LASER.
E. Panizza and P. J. Regensburger (Rochester, University, Institute of Optics, Rochester, N.Y.).
Physics Letters, vol. 24A, Mar. 13, 1967, p. 321, 322. 5 refs. Army-supported research.

Observation of attenuation of a tunable probe beam in CS_2 in the presence of intense radiation from a ruby laser. The dependence of this attenuation on the probe beam wavelength and laser intensity is measured. The results are believed to suggest the presence in CS_2 of two-photon absorption. V.Z.

A67-23779 #
LUMINESCENCE OF CdS AT LOW TEMPERATURE EXCITED BY VERY HIGH INTENSITY LIGHT (LASER).
A. Mysyrowicz, J. B. Grun, S. Nikitine (Strasbourg, Université, Institut de Physique, Laboratoire de Spectroscopie et d'Optique du Corps Solide, Strasbourg, France), and F. Raga (Strasbourg, Université, Institut de Physique, Laboratoire de Spectroscopie et d'Optique du Corps Solide, Strasbourg, France; Cagliari, Università, Istituto di Fisica, Cagliari, Italy).
Physics Letters, vol. 24A, Mar. 13, 1967, p. 335, 336. 6 refs.

Brief note on the observation of a shift toward the lower energy end in the emission spectrum of CdS crystals excited by very intense laser light. It is contended that the shift is not caused by a temperature effect because the lines remain in the same position when the light beam intensity is changed. It is believed, rather, that the optical longitudinal phonons of the crystal contribute to the shift. V.Z.

A67-23782
MEASUREMENTS OF BEAM DIVERGENCE OF Q-SWITCHED RUBY LASER RODS.
P. V. Avizonis, T. T. Doss, and R. Heimlich (USAF, Systems Command, Research and Technology Div., Weapons Laboratory, Kirtland AFB, N. Mex.).
Review of Scientific Instruments, vol. 38, Mar. 1967, p. 331-334. 9 refs.

A method of measuring beam divergence is reported that provides simultaneous variable intensity multiple exposures of the laser output on Polaroid film, and does not require densitometer tracings of the exposures to establish the beam divergence. Using this technique, beam divergence as a function of power output of 12 "Q-switched" ruby rods is reported. Inference is made that the active divergence of a ruby rod is the sum of the passive beam divergence of that rod plus the divergence due to radial mode structure. Thermal distortion probably contributes very little to the beam divergence. (Author)

A67-23793 #
RELATION OF LASER INDUCED ION ENERGY TO LASER POWER.
Susumu Namba, Pil Hyon Kim, Takashi Itoh (Institute of Physical and Chemical Research, Tokyo, Japan), Tsutomu Arai, and Naoharu Kinoshita (Toyo University, Faculty of Engineering, Kawagoe, Saitama, Japan).
Japanese Journal of Applied Physics, vol. 6, Feb. 1967, p. 273. 10 refs.

Brief description of experimental results for the dependence of ion energies on irradiated laser power. The laser beam was focused on a tantalum target with a lens of focal length 50 mm and the area of the focal spot was approximately 2×10^{-3} cm^2. The distance between the target and the collector was 16 mm. The mechanism for the production of ions with two discrete energies is discussed. R.B.S.

A67-24006
QUIESCENT-PLASMA RESEARCH PROGRAM AT THE UNIVERSITY OF MARYLAND.
H. Lashinsky (Maryland, University, Institute for Fluid Dynamics and Applied Mathematics, College Park, Md.).
IN: PLASMA INSTABILITIES AND ANOMALOUS TRANSPORT; PROCEEDINGS OF A CONFERENCE ON INSTABILITIES AND ANOMALOUS LOSS PROCESSES IN STEADY STATE PLASMAS, UNIVERSITY OF MIAMI, CORAL GABLES, FLA., MAY 2-4, 1966. [A67-23997 11-25]
Edited by W. B. Pardo and H. S. Robertson.
Coral Gables, Fla., University of Miami Press, 1966, p. 145-148.

Discussion of the design objectives and proposed features of a thermal plasma device or "Q-machine," in which the instabilities of plasma will be studied experimentally. It is pointed out that the plasma oscillations associated with the universal instabilities in a Q-machine have much in common with the normal-mode oscillations in the gas laser, both being cases of nonequilibrium distributed systems. Some of the details of this analogy are discussed.
M.F.

A67-24133
PHOTON-ENHANCED FIELD EMISSION FROM CdS SINGLE CRYSTALS.
S. Akram Husain and D. Walsh (Oxford University, Dept. of Engineering Science, Oxford, England).
Electronics Letters, vol. 3, Mar. 1967, p. 121, 122. 8 refs.
Research supported by the Science Research Council; Grant No. AF EOAR 65-37.

In a previous experiment, field emission was observed from sharply pointed CdS single crystals. The experiments have now been extended, illuminating the tip with light from a pulsed argon-ion laser. It was found that (1) the voltage threshold at which emission can be observed is reduced, typically from 500 to 400 v, (2) under some conditions, the emission is increased by a factor of 10^3, (3) this emission persists for more than 2×10^{-2} sec after the laser pulse and appears to have two characteristic decay times, (4) the emission is approximately proportional to the light intensity, and (5) the greatest photo-enhanced field emission was obtained with the laser light shining axially on the emitting area of the tip.
(Author)

A67-24236
MODULATION OF LASER BEAMS BY ATMOSPHERIC TURBULENCE - DEPTH OF MODULATION.
M. Subramanian and J. A. Collinson (Bell Telephone Laboratories, Inc., New York, N.Y.).
(Institute of Electrical and Electronics Engineers, Quantum Electronics Conference, 4th, Phoenix, Ariz., Apr. 12-15, 1966, Paper.)
Bell System Technical Journal, vol. 46, Mar. 1967, p. 623-648. 15 refs.

Study of the fluctuations produced in a laser beam by atmospheric turbulence over transmission paths up to 2400 ft as a function of size of receiving aperture, range, and atmospheric conditions. The depth of modulation decreases rapidly with increasing size of receiving aperture for apertures smaller than the direct beam. It does not go to zero, however, but levels off at an approximately constant, finite value for apertures larger than the direct beam. When all of the direct beam is collected, the depth of modulation varies approximately with the 3/2 power of range from about 100 to 2400 ft. At ranges less than about 100 ft the dependence is consistently much less than 3/2. The 3/2 dependence is consistent with near-field scattering theory, and leads to an estimate for the lower bound of the effective scale size of turbulence of 5 cm. The depth of modulation depends sensitively on atmospheric conditions.
F.R.L.

A67-24239
QUANTUM NOISE VII - THE RATE EQUATIONS AND AMPLITUDE NOISE IN LASERS.
Melvin Lax (Bell Telephone Laboratories, Inc., Theoretical Physics Research Dept., Murray Hill, N.J.).
(Institute of Electrical and Electronics Engineers, Quantum Electronics Conference, 4th, Phoenix, Ariz., Apr. 12-15, 1966, Paper.)
IEEE Journal of Quantum Electronics, vol. QE-3, Feb. 1967, p. 37-46. 58 refs.

In the paper we start from our Quantum Noise IV model of a homogenously broadened maser and specialize to the case in which the number of photons and the population difference are the slowest changing variables. In spite of the high coherence of the system, we find that by eliminating all other variables adiabatically we obtain the usual rate equations plus a set of noise sources with precisely those moments appropriate to shot noise. Thus we justify McCumber's model for amplitude noise in a laser, and after making a quasi-linear approximation obtain his amplitude spectrum. Comparison with exact calculations of Hempstead and Lax for the rotating wave van der Pol oscillator suggests that quasi-linear methods are accurate except within a factor 10 (in photon number) of threshold.
(Author)

A67-24241
ENERGY LOSSES IN A PASSIVE Q-SWITCHED RUBY LASER.
V. Degiorgio and G. Potenza (Centro Informazioni Studi Esperienze, Laboratori, Milan, Italy).
IEEE Journal of Quantum Electronics, vol. QE-3, Feb. 1967, p. 59-65. 20 refs.
Research supported by the Consiglio Nazionale delle Ricerche.

An experimental investigation has been performed in order to explain why the output energy from a ruby laser is always reduced when passing from normal laser operation to Q-switching operation. A saturable absorber was used as the switching element; however, the discussion about the energy losses is valid for every Q-switching system. Experimental data allow one to evaluate the decrease of the output energy due to the reduced pumping efficiency, to the losses in the optical switch, and to the incomplete depletion of the inversion arising from the spatial inhomogeneity of the standing wave in the resonator and from the relaxation processes in the ruby line.
(Author)

A67-24242
CONSTRUCTION OF LONG LIFE ARGON LASERS.
K. G. Hernqvist (Radio Corporation of America, RCA Laboratories, Electronics Research Laboratory, Princeton, N.J.) and J. R. Fendley, Jr. (Radio Corporation of America, RCA Laboratories, Princeton, N.J.).
IEEE Journal of Quantum Electronics, vol. QE-3, Feb. 1967, p. 66-72. 20 refs.

The Tonks-Langmuir theory for the low-pressure positive column is reviewed and shown to be applicable to argon ion laser operation. Under these conditions ions formed in the plasma are accelerated and move by free fall to the wall. The sputtering effects of the ions on the plasma confining structure are evaluated for both a uniform insulator wall and a sectioned metal wall. A test is described where materials suitable for a sectioned column are compared. Of the materials tested (Ta, Mo, and graphite), graphite is shown to have outstanding properties for argon laser applications. A successful 1000-hour life test is described. Only slight sputtering damage was observed for the graphite plasma confining structure. Design considerations for long life argon lasers are discussed. These include choice of cathode, electrode shapes, plasma confinement structure, and tube processing. Solutions to the argon cleanup problem are described. Argon lasers built according to these recommendations are exemplified. (Author)

A67-24244
GAIN CHARACTERISTICS OF CO_2 LASER AMPLIFIERS AT 10.6 MICRONS.
P. K. Cheo and H. G. Cooper (Bell Telephone Laboratories, Inc., Whippany, N.J.).
(Institute of Electrical and Electronics Engineers, Electron Devices Research Conference, California Institute of Technology, Pasadena, Calif., June 22-24, 1966, Paper.)
IEEE Journal of Quantum Electronics, vol. QE-3, Feb. 1967, p. 79-84. 14 refs.

Single-pass gain at 10.6 microns has been studied parametrically in nonflowing CO_2 or buffered CO_2 amplifying media. The gain profile across the amplifier diameter and integrated gain both were determined. Parameters varied included buffer gas type, mixture ratio, gas pressure, amplifier bore, discharge current, and wall temperature. Tube bores of 12, 22, and 34 mm and buffer gases of H_2, He, Ne, A, and N_2 were studied. Optimum gain is relatively independent of current density, but decreases with increasing wall temperature. The pressure-diameter relationship $P_{CO_2} \cdot D \sim 4$ torr-cm was found to hold for CO_2, CO_2:He, and CO_2:N_2 amplifying media at optimum gain. The gain depends strongly on the CO_2 partial pressure and is relatively insensitive to the buffer gas pressure except for the case of H_2. The maximum gain decreased slowly with increasing amplifier diameter. The highest gain, 1.7 db/meter, was achieved with a helium buffer gas in amplifiers with a diameter of 22 mm or less. No gain saturation was detected for a

30-db range of input signal power, from a milliwatt to a few watts. Spectrograms showed that the principal spontaneous emission from CO_2:He amplifiers in the 2000-7000-Å range consisted of CO bands; no CO_2 bands or He line spectra were observed. (Author)

A67-24245
A NONRESONANT MULTIPASS CO_2-LASER AMPLIFIER.
H. Kogelnik and T. J. Bridges (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
IEEE Journal of Quantum Electronics, vol. QE-3, Feb. 1967, p. 95, 96.

Description of a compact five-pass CO_2-laser amplifier structure to obtain small-signal gains of about 15 db at a wavelength of 10.6 μ. A power output of 5.5 watt was measured at a saturated gain of 7 db. The laser gas discharge was 1 m long and was contained in a water-cooled glass tube of 20 mm bore. The tube was terminated by Brewster angle windows of potassium chloride. A multipass structure consisting of two spherical mirrors was used to provide for ray systems that are reentrant after six transversals. To increase diffraction losses masks with circular holes were inserted in front of each mirror. F. R. L.

A67-24252 * #
HOW GOOD ARE LASERS FOR DEEP-SPACE COMMUNICATIONS?
E. J. Reinbolt (NASA, Marshall Space Flight Center, Astrionics Laboratory, Applied Research Branch, Huntsville, Ala.) and J. L. Randall (NASA, Marshall Space Flight Center, Astrionics Laboratory, Applied Research Branch, Applied Physics Section, Huntsville, Ala.).
Astronautics and Aeronautics, vol. 4, Apr. 1967, p. 64-70. 9 refs.

Study showing that optical systems are promising, particularly when combined with rf techniques, for the realization of high-information-rate deep-space communication systems. The great potential of optical frequencies for the transmission of high data rates from deep space to earth resides mainly in the very tight optical beam, or high antenna gain. It is pointed out that rf communications systems have been developed to a very advanced technology, and that the only way to improve the data-rate capability of these systems from deep space is to increase transmitter power or to increase the size of the transmitter and receiver antennas, which are already approaching practical limits. On the other hand, optical, and IR communication systems have room for improvement with increased laser efficiency, better detectors and modulators, and a reasonable increase in antenna size and transmitter power output. M. F.

A67-24419
DETECTABILITY OF COHERENT OPTICAL SIGNALS IN A HETERODYNE RECEIVER.
Carl W. Helstrom (Westinghouse Electric Corp., Atomic, Defense and Space Group, Research and Development Center, Research Laboratories, Pittsburgh, Pa.).
Optical Society of America, Journal, vol. 57, Mar. 1967, p. 353-361. 17 refs.

In the heterodyne receiver considered here, a coherent optical signal and incoherent Gaussian background radiation impinge on a photosensitive surface together with the beam from a laser functioning as a local oscillator. The moment-generating function for the output current is derived. When the laser beam is much stronger than either signal or background, the output current consists of an i.f. signal and Gaussian noise. The effective signal-to-noise oscillator that determines the detectability of the signal is calculated as a function of the signal and local-oscillator fields at the photosurface. An integral equation is given for the local-oscillator field that maximizes the signal-to-noise ratio; it involves the signal field and the coefficient of partial coherence of the background. For a uniform background, the local-oscillator field must be a replica of the signal field. (Author)

A67-24420 *
CALCULATION OF FRINGE VISIBILITY IN A LASER-ILLUMINATED INTERFEROMETER.
Edwin F. Erickson and Richard M. Brown (NASA, Ames Research Center, Moffett Field, Calif.).
Optical Society of America, Journal, vol. 57, Mar. 1967, p. 367-371. 9 refs.

A calculation of the fringe visibility in a laser-illuminated two-beam interferometer is presented and discussed. The laser is assumed to be oscillating in several adjacent axial modes whose intensities are determined by the Doppler-broadened emission line. An exact expression is given for the visibility as a function of path-length difference, and it is shown to be the product of an exponential envelope and a periodic function whose period is very nearly twice the length of the laser. An important special case is considered to illustrate the values of path-length difference for which the visibility is minimum. Finally, the visibility is plotted in a way which permits estimation of depth of field in holography or acceptable path mismatch in interferometry. For any laser operating in the assumed manner, calculation is simplified by the form of the equations. An example is given. (Author)

A67-24433 *
A LASER DEVICE FOR REMOTE VIBRATION MEASUREMENT.
John V. Foster (NASA, Ames Research Center, Systems Engineering Div., Moffett Field, Calif.).
IEEE Transactions on Aerospace and Electronic Systems, vol. AES-3, Mar. 1967, p. 154-157. 5 refs.
Contract No. NAS 2-3137.

A laboratory study has been made of concepts that utilize a laser for a vibration measurement device. The laser beam possesses the needed characteristics for a spatially directed carrier capable of detecting and transmitting vibration information to remote data processing equipment; furthermore, such a laser vibration measurement device can accomplish the measurement without mechanical contact with the structure under test. The measurement technique utilizes the Doppler shift produced on a wave reflected from a surface vibrating normal to the beam path. Several techniques are available for detecting the Doppler shift; optical heterodyne or homodyne detection and microwave subcarrier modulation methods are candidates for practical instruments. Preliminary results from laboratory experiments indicate optical heterodyne detection to be the most practical method with present state-of-the-art equipment. (Author)

A67-24467 #
A SOLID-STATE MASER OPERATING WITH A MICROREFRIGERATOR AT A TEMPERATURE OF 40°K.
P. S. Lifanov, L. I. Nevostrueva, M. P. Stolpianskii, K. V. Filatov, and V. B. Shteinshleiger.
(Radiotekhnika i Elektronika, vol. 11, Sept. 1966.)
Radio Engineering and Electronic Physics, vol. 11, Sept. 1966, p. 1383-1386. 7 refs. Translation.

Description of a ruby maser operating with a closed-cycle refrigerator of small size at a temperature of 40°K. It is shown that in a single-cavity version of this device the broadband parameter attains 19 MHz in the 3-cm region. It is found that the use of two degenerate modes in the ruby cavity increases the bandwidth approximately threefold, while the noise temperature of the maser does not exceed 70°K. A.B.K.

A67-24468 #
THE EFFECT OF SATURATION OF SOLID-STATE MASERS ON THEIR PHASE CHARACTERISTICS.
L. L. Moskvitin and B. F. Poltoratskii.
(Radiotekhnika i Elektronika, vol. 11, Sept. 1966.)
Radio Engineering and Electronic Physics, vol. 11, Sept. 1966, p. 1386-1389. 5 refs. Translation.

Results of a theoretical study of the effect of saturation on the phase characteristics of traveling-wave masers and reflex-type cavity masers. On the basis of a quantitative investigation of the saturation of maser amplifiers, the phase shift is determined as a function of the input signal level for traveling-wave amplifiers and reflex-type cavity amplifiers. It is shown that the curves obtained can be used for estimating the signal distortions in various phase-meter radio-receiving devices which incorporate masers. A.B.K.

A67-24479 #
EXACT MEASUREMENT OF THE VELOCITY OF LIGHT BY MEANS OF A Ne-H LASER.
V. P. Chebotaev.
(Radiotekhnika i Elektronika, vol. 11, Sept. 1966.)
Radio Engineering and Electronic Physics, vol. 11, Sept. 1966, p. 1506-1508. 9 refs. Translation.

Description of a technique for measuring the velocity of light with the aid of a Ne-H laser. It is shown that by using a hollow-cathode discharge in a Ne-H mixture the difference between the oscillating wavelengths can be measured to an accuracy no less than 10^{-8}. A description is given of an oscillator in which such a discharge was achieved, and a plot of the oscillation power vs cavity length at the 11,143-Å line is presented. A.B.K.

A67-24560
LASER-PRODUCED DIELECTRIC BREAKDOWN IN LIQUIDS WITH RESULTING ABSORPTION OF A SECONDARY LIGHT BEAM.
M. W. Dowley, K. B. Eisenthal, and W. L. Peticolas (International Business Machines Corp., Research Laboratory, San Jose, Calif.).
Physical Review Letters, vol. 18, Apr. 3, 1967, p. 531-533. 9 refs.

Observation of phenomena attributed to laser-produced dielectric breakdown in various liquids. It is seen that absorption, scattering, and emission result from dielectric breakdown at particle sites in the liquids. Careful filtering reduces these effects. M.F.

A67-24561
POSSIBLE OBSERVATIONS OF COLLISIONLESS ELECTROSTATIC SHOCKS IN LASER-PRODUCED PLASMAS.
D. W. Koopman and D. A. Tidman (Maryland Institute of Technology, Bethesda; Maryland, University, College of Engineering, Institute for Fluid Dynamics and Applied Mathematics, College Park, Md.).
Physical Review Letters, vol. 18, Apr. 3, 1967, p. 533-535. 6 refs.

Experimental investigation of laser-produced plasmas, in which granules of LiD were irradiated by 15-nsec, 3-joule pulses from a ruby laser. Some preliminary results of an experiment in which the plasma ball expands into an ambient plasma are described. The results suggest that a thin, "collisionless," electrostatic shock front propagating radially at the leading edge of the plasma ball is observed. M.F.

A67-24649 #
TRANSIENT EMISSION OF A PULSED ARGON ION LASER.
G. Redaelli and A. Sona (Centro Informazioni Studi Esperienze, Laboratori, Milan, Italy).
Alta Frequenza, vol. 36, Feb. 1967, p. 150-152. 9 refs.
Research supported by the Consiglio Nazionale delle Ricerche.

Some emission characteristics of a pulsed argon ion laser are reported. A delay of the order of some milliseconds in laser emission is observed when the discharge is started in cold gas. This effect with the used geometry (capillary discharge) is essentially due to radiation trapping effects of the lower laser level. (Author)

A67-24664 *
ZEEMAN DISCHARGE TUBE FREQUENCY MONITOR.
Frederick Aronowitz, Harry A. Gustafson, and Joseph E. Killpatrick (Honeywell, Inc., Systems and Research Center, Minneapolis, Minn.).
Applied Optics, vol. 6, Apr. 1967, p. 695-698.
NASA-supported research.

A discriminant to frequency stabilize a gas laser has been obtained from a discharge tube in which the gain profile is split by an ac magnetic field. By superimposing a dc magnetic field, the discriminant can be centered at any point on the gain profile. By employing feedback techniques, the center of the discriminant can be used to track a laser frequency; the magnitude of the dc magnetic field determines the displacement of the laser frequency from the gain maximum. (Author)

A67-24665
EFFECTS OF THE ATMOSPHERE ON LASER BEAM PROPAGATION.
A. L. Buck (National Center for Atmospheric Research, Boulder, Colo.).
Applied Optics, vol. 6, Apr. 1967, p. 703-708. 19 refs.
USAF-sponsored research.

An experimental study of horizontal laser beam propagation over paths up to 145 km long was made in which beam diameter and shape, intensity fluctuations, and optical phase distortion were measured. It was found that (1) received beam diameter decreases (on-axis power density increases) with increasing transmitter aperture to a limit reached at an aperture of about 11 cm, (2) beam diameter varies as the 1.2 power of path length, (3) the amplitude of intensity fluctuations decreases with increasing receiver aperture and is nearly independent of path length for paths longer than 0.55 km, (4) the fluctuation spectrum shows a decrease in spectral power with increasing frequency, this negative slope becoming steeper with increasing receiver aperture and remaining constant with path length, and (5) rms fluctuation in phase path length was observed to be 0.25 μ over a 48.8-m path. In addition, it is shown that geometrical optics based on the effects of large scale atmospheric irregularities does not adequately account for signal intensity fluctuations. These results may be helpful in predicting the capability of specific communications systems and in understanding better the nature of atmospheric turbulence. (Author)

A67-24667
TRANSIENT SOLUTIONS TO A THREE LEVEL MASER.
M. L. Narchal, M. M. Dhawan, and M. R. Monga (Kurukshetra University, Dept. of Physics, Kurukshetra, India).
Applied Optics, vol. 6, Apr. 1967, p. 723-726. 17 refs.

The transient behavior of three-level paramagnetic masers is investigated theoretically. Exact solutions to three-level maser rate equations are developed and their significance discussed. The results indicate the possibility of obtaining enhanced maser action at low saturation by pulsed pumping. A new method for the measurement of spin-lattice relaxation times for a three-level maser is proposed. The method, in addition to certain well known static measurements, requires the observation of the decay of the signal strength when the pumping field is switched off. (Author)

A67-24715 *
FAR-INFRARED LASER POWER MEASUREMENTS.
F. Arams, C. Allen, M. Wang (Cutler-Hammer, Inc., Airborne Instruments Laboratory Div., Melville, N.Y.), K. Button, and L. Rubin (Massachusetts Institute of Technology, National Magnet Laboratory, Cambridge, Mass.).
IEEE, Proceedings, vol. 55, Mar. 1967, p. 420. 6 refs.
USAF-supported research; Contract No. NAS 12-6.

Measurements of the peak and average output power of a 337-μ cyanide laser. The tests indicated the usefulness at this high frequency of available oversize waveguide instrumentation - i.e., a room-temperature average-power measuring bolometer, a liquid helium-cooled InSb detector-mixer, and a double-prism attenuator. F.R.L.

A67-24717
A PHOTOCHROMIC LASER DISPLAY.
Vernon J. Fowler and Elliott S. Kohn (General Telephone and Electronics Laboratories, Inc., Bayside, N.Y.).
IEEE, Proceedings, vol. 55, Mar. 1967, p. 424, 425.

Projection of high-contrast images generated on a photochromic plate positioned within a laser cavity by use of an enlarged internal laser beam. An opaque image on the plate caused the coherent light passing through it to be diffracted. A flat oblique-apertured mirror reflected this diffracted light out of the cavity onto a screen. F.R.L.

A67-24724
THE RADIATION PATTERN OF A TRUNCATED GAUSSIAN APERTURE DISTRIBUTION.
Arden L. Buck (National Center for Atmospheric Research, Boulder, Colo.).

IEEE, Proceedings, vol. 55, Mar. 1967, p. 448-450.

The optical configuration allowing most efficient transmission of laser beams over long distances has been determined from the computer calculations described, which give the radiation pattern and received intensity of arbitrarily truncated Gaussian aperture distributions. Some representative radiation patterns and received intensity vs beam truncation are plotted. (Author)

A67-24727

C-BAND TRAVELING-WAVE MASER USING A SLOW-WAVE STRUCTURE PRINTED ON RUBY.

B. Loriou and J. L. Jaouen (Centre National d'Etudes des Télécommunications, Lannion, Côtes-du-Nord, France).

IEEE, Proceedings, vol. 55, Mar. 1967, p. 461, 462.

Description of a C-band traveling-wave maser utilizing metallized rubies, the slow-wave structure being directly photoetched on ruby. The advantages of the technology are reduced size and easy realization of small pitches, resulting in high slowing factors. F.R.L.

A67-24728

TIME DEPENDENCE OF THE POWER OUTPUT AT 119 μ IN A WATER VAPOR LASER.

Eric Brannen, V. Sochor, W. J. Sarjeant, and H. R. Froehlich (Western Ontario, University, London, Ontario, Canada).

IEEE, Proceedings, vol. 55, Mar. 1967, p. 462, 463.

Research supported by the National Research Council of Canada; Grant No. AF AFOSR 297-66.

The power output pulse at 119 μ in a water vapor laser was observed for discharge current durations up to 6 μsec. Laser action did not occur until the end of the discharge current pulse, indicating that laser action is inhibited during the discharge for the pulse lengths and currents used. (Author)

A67-24735

COHERENT AND NONCOHERENT LIGHT EMISSION IN II-VI COMPOUNDS.

D. C. Reynolds (USAF, Office of Aerospace Research, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio).

(Annual Technical Conference on Preparation and Properties of Electronic Materials for the Control of Radiative Processes, 8th, Boston, Mass., Aug. 29-31, 1966, Paper.)

AIME, Transactions, vol. 239, Mar. 1967, p. 300-310. 26 refs.

Recent experiments with II-VI compounds have shown that they have considerable potential for laser applications over a broad region of the optical spectrum. It may be possible to cover the spectrum continuously from 3200 Å (ZnS) to the far infrared (CdHg:Te) since HgTe is a semimetal. At this writing laser action has been observed in ZnS, ZnO, CdS, CdSe, CdS:Se, CdTe, and some of the CdHg:Te alloys. Of particular interest are those lasers operating in the visible and near ultraviolet regions of the spectrum where detectors of high sensitivity are available. The lasing transi-

A67-24737

MULTIPLY REFLECTIVE LASER DETECTOR DIODE.

P. H. Wendland (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.).

(Annual Technical Conference on Preparation and Properties of Electronic Materials for the Control of Radiative Processes, 8th, Boston, Mass., Aug. 29-31, 1966, Paper.)

AIME, Transactions, vol. 239, Mar. 1967, p. 321-326. 5 refs.

Contract No. AF 33(615)-3591.

Calculations are presented for the design of a silicon photodiode in which the incident light beam makes multiple passes between the detector surfaces. Total internal reflection is used for this "light-trapping" effect. By this means, the optical path length can be extended to several millimeters, while the electrode separation remains less than 10^{-2} cm, as required for nanosecond response time. Data are presented for a Schottky barrier photodiode constructed on a multiply reflecting silicon base wafer. It is shown tha the long-wavelength response is considerably extended in such structures without a corresponding sacrifice in high-speed response. (Author)

A67-24739

OPTICAL AND LASER PROPERTIES OF Nd^{+3}- AND Eu^{+3}-DOPED YVO_4.

J. R. O'Connor (Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Mass.).

(Annual Technical Conference on Preparation and Properties of Electronic Materials for the Control of Radiative Processes, 8th, Boston, Mass., Aug. 29-31, 1966, Paper.)

AIME, Transactions, vol. 239, Mar. 1967, p. 362-365. 12 refs.

Stimulated emission from Nd^{+3} in yttrium vanadate (YVO_4) is reported. Single crystals of YVO_4:Nd, obtained from Linde, have improved substantially in the last several months. Pulsed thresholds of YVO_4 laser rods are now approximately 2 to 3 joules, comparable to those for YAG:Nd. Yttrium vanadate crystallizes in a space group similar to zircon. All rare-earth vanadates have this structure. Rare-earth ions such as Nd^{+3}, which substitutes for Y^{+3}, are situated in a strong tetragonal crystal field which lacks inversion symmetry. This condition increases the probability of the parity-forbidden $f \rightarrow f$ transitions. Yttrium vanadate has strong absorption bands beyond 4000 Å. These are due to Y-O, V-O charge transfer and $(VO_4)^{-3}$ molecular transitions. Under 2537 and 3660-Å irradiation pure YVO_4 fluoresces a bright yellow. This fluorescence is completely quenched in YVO_4:Nd crystals. This and other evidence of energy transfer from the lattice is reported. Optical and laser properties of YVO_4:Eu are briefly described. (Author)

A67-24741

VAPOR-PHASE GROWTH OF $GaAs_{1-x}P_x$ ROOM-TEMPERATURE INJECTION LASERS.

J. J. Tietjen, J. I. Pankove, I. J. Hegyi, and H. Nelson (Radio Corporation of America, RCA Laboratories, Princeton, N.J.).

(Annual Technical Conference on Preparation and Properties of Electronic Materials for the Control of Radiative Processes, 8th, Boston, Mass., Aug. 29-31, 1966, Paper.)

AIME, Transactions, vol. 239, Mar. 1967, p. 385-387. 18 refs.

ARPA Contract No. SD-182.

Discussion of experiments in which the fabrication of p-n junctions in $GaAs_{1-x}P_x$ alloys by a vapor-phase growth technique has for the first time resulted in room-temperature injection lasers capable of operating over a broad range of wavelengths extending into the visible region of the spectrum. The shortest wavelength achieved to date is 6750 Å at room temperature. In addition, at 78°K the threshold current density values for these lasers are generally the lowest reported, and the emitted radiation extends to the lowest wavelength ever attained (6350 Å). With lasers fabricated from material containing 14% GaP, quantum efficiencies of 26% and peak power outputs of 25 watts were obtained at room temperature. M.F.

A67-24744

THERMAL RESISTANCE OF GaAs LASER DIODES.

S. Caplan (Radio Corporation of America, RCA Electronic Component and Devices Div., Technical Programs Laboratory, Somerville, N.J.), T. Gonda, M. F. Lamorte, and P. Nyul (Radio Corporation of America, RCA Electronic Component and Devices Div., Optical Products Dept., Somerville, N.J.).

(Annual Technical Conference on Preparation and Properties of Electronic Materials for the Control of Radiative Processes, 8th, Boston, Mass., Aug. 29-31, 1966, Paper.)

AIME, Transactions, vol. 239, Mar. 1967, p. 403, 404. 6 refs.

Contract No. DA-44-099-AMC-1287(T).

Measurement of thermal resistance on GaAs laser diodes in the temperature range from 77 to 300°K. The data show that typically the thermal resistance increases by a factor of 15 from 77 to 300°K. The increase is attributed to the decrease in thermal conductivity of GaAs. Normalized thermal-resistance experimental and calculated values (the latter from published thermal-conductivity data) are compared, and good agreement is shown. M.F.

A67-24745
HIGH POWER STACKED GaAs LASER ARRAYS.
D. R. Muss, C. S. Duncan (Westinghouse Electric Corp., Atomic, Defense and Space Group, Research and Development Center, Research Laboratories, Pittsburgh, Pa.), and S. Scuro (Westinghouse Electric Corp., Atomic, Defense and Space Group, Research and Development Center, Research Laboratories, Applied Physics Dept., Pittsburgh, Pa.).
(Annual Technical Conference on Preparation and Properties of Electronic Materials for the Control of Radiative Processes, 8th, Boston, Mass., Aug. 29-31, 1966, Paper.)
AIME, Transactions, vol. 239, Mar. 1967, p. 404-408.

Account aimed at accentuating the specific attributes of the GaAs laser diode - its small size and high efficiency. This was done by reducing transport losses in the bulk p and n regions of the diode and combining many of these diodes into series stacks with common optical cavities. The result of this effort is a nearly monochromatic source at about 8450 Å with a luminous area 0.05 by 0.05 cm emitting peak pulse powers above 300 watts at repetition rates below 200 pulses/sec into a cone about 0.01 ster when operated at 77°K. The results of measurements of peak optical power and spectra from these stacks are reported, and some conclusions are drawn about the role the individual diodes play in the stacked operation. M.F.

A67-24754
MEASUREMENT OF THE Q PARAMETER OF A HYDROGEN MASER [MESURE DU PARAMETRE Q D'UN MASER A HYDROGENE].
Claude Audoin, Michel Desaintfuscien, and Jean-Pierre Schermann (Paris, Université, Institut d'Electronique Fondamentale, Orsay, Seine-et-Oise, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 9, Feb. 27, 1967, p. 698-701. 6 refs.
In French.

Proposal of two new methods of measurement of the q parameter defined by Ramsey et al., one of which can be applied without modification of the structure of the clock. There is good agreement between the results thus obtained and those of the inhomogeneous magnetic field method of Vanier-Vessot. In the regime of high atom density it has been possible to measure $T_{2c}/T_{1c} = 2.10 \pm 0.15$. F.R.L.

A67-24829
OPTICAL ANALOG OF THE TRANSIENT NUTATION EFFECT.
C. L. Tang (Cornell University, School of Electrical Engineering, Ithaca, N.Y.) and H. Statz (Raytheon Co., Research Div., Waltham, Mass.).
Applied Physics Letters, vol. 10, Mar. 1, 1967, p. 145-147. 8 refs.
ARPA-supported research.

Consideration of the possibility of observing the optical transient nutation effect in CO_2 lasers. The principal requirement for the observation of the effect is that the frequency of the expected modulation Ω, which is directly proportional to the optical field strength, must be of the order of (or larger than) the linewidth of the laser transition. A formula for the nutation frequency is derived explicitly for the vibrational-rotation transitions in molecules such as CO_2. F.R.L.

A67-24830 *
ABSOLUTE FREQUENCY MEASUREMENT AND SPECTROSCOPY OF GAS LASER TRANSITIONS IN THE FAR INFRARED.
L. O. Hocker, A. Javan, D. Ramachandra Rao (Massachusetts Institute of Technology, Dept. of Physics, Cambridge, Mass.), L. Frenkel, and T. Sullivan (NASA, Electronics Research Center, Cambridge, Mass.).
Applied Physics Letters, vol. 10, Mar. 1, 1967, p. 147-149. 7 refs.
USAF-NASA-supported research.

Measurement of absolute frequencies of the 311-μ and the 337-μ transitions of the CN gas laser to within a few parts in 10^7. This is achieved by mixing the laser frequencies with high-order harmonics of a microwave signal in a silicon diode. The beat frequencies of these two transitions, which fall at 73.5 GHz is also measured directly. The Zeeman effect of these transitions is studied. Based on a detailed analysis, it is found that the existing identification of the transitions is inconsistent with the observations. F.R.L

A67-24832
OPTICAL HETERODYNE MEASUREMENT OF NEON LASER'S MILLIMETER WAVE DIFFERENCE FREQUENCY.
J. L. Hall and W. W. Morey (National Bureau of Standards and Colorado, University, Joint Institute for Laboratory Astrophysics, Boulder, Colo.).
Applied Physics Letters, vol. 10, Mar. 1, 1967, p. 152-155. 15 refs.
Contract No. DA 31 124 ARO(D)-139.

We report detection and measurement of the millimeter wave difference frequency between two near laser lines at 1.152 μ. The two spectral transitions, separated by 2.26 Å, oscillate in pure neon in a single laser device, producing about 150 μw total power in several longitudinal modes. The many resulting 51.3-Gc beat frequencies have been studied by optical heterodyne techniques. A type of diode has been found which has enough microwave sensitivity and enough optical sensitivity to combine the optical detector and the microwave heterodyne functions in a single element. The preliminary value for the difference in frequency between the $2S_2 \rightarrow 2P_4$ and $2S_4 \rightarrow 2P_7$ transitions in neon at 150 mtorr is (51,360 ±150) Mc. This value is not in agreement with the value calculated by Sitterly. (Author)

A67-24833 *
LASER ACTION FROM TERBIUM TRIFLUOROACETYLACETONATE IN P-DIOXANE AND ACETONITRILE AT ROOM TEMPERATURE.
Sven Bjorklund, G. Kellermeyer, C. R. Hurt (Lockheed Aircraft Corp., Lockheed Electronics Co., Goddard Space Flight Center, Greenbelt, Md.), N. McAvoy (NASA, Goddard Space Flight Center, Greenbelt, Md.), and N. Filipescu (George Washington University, Dept. of Chemistry, Washington, D.C.).
Applied Physics Letters, vol. 10, Mar. 1, 1967, p. 160-162.

Observation of laser activity from a terbium β-ketoenolate at room temperature in liquid solution. It is believed that this is the first time terbium has been made to lase. The liquid laser material consisted of a 2.5×10^{-3}-M solution of terbium tris (1, 1, 1-trifluoroacetylacetonate) in acetonitrile or in p-dioxane. Threshold pumping energy is about 1700 joules. Characteristic line narrowing, spiking, and beam collimation were exhibited. F.R.L.

A67-24836
THERMAL SWITCHING OF LASER EMISSION OF Er^{3+} AT 2.69 μ AND Tm^{3+} AT 1.86 μ IN MIXED CRYSTALS OF $CaF_2:ErF_3:TmF_3$.
M. Robinson and D. P. Devor (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.).
Applied Physics Letters, vol. 10, Mar. 1, 1967, p. 167-170. 9 refs.
USAF-supported research.

Pronounced temperature-dependent transfer of excitation from the Er^{3+} laser pump levels to lower levels of Er^{3+} was observed in $CaF_2:ErF_3$ single crystals at ErF_3 concentrations exceeding 12.5 wt%. Transfer of excitation from Er^{3+} to Tm^{3+} occurred when TmF_3 was included as a second active constituent of the crystals. Stimulated emission of the $^4I_{11/2} \rightarrow {}^4I_{13/2}$ transition of Er^{3+} at 2.69 μ at 298°K resulted independently of Tm^{3+} and as a consequence of concentration quenching of emission of Er^{3+} from levels above $^4I_{11/2}$. At 100°K reduced transfer of excitation to $^4I_{11/2}$ of Er^{3+} occurred due to radiative emission from levels above $^4I_{11/2}$, and laser emission of Tm^{3+} was detected at 1.86 μ. (Author)

A67-24841
HIGH GAIN PULSED LASER.
A. D. Brisbane (International Telephone and Telegraph Corp., Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England).
Nature, vol. 214, Apr. 1, 1967, p. 75.

Observation of a superradiant transition at $\lambda = 1.793\mu$. Three lines are observed between 1.27 and 2.4 μ; these are assumed to be due to transitions which are tabulated. The silica tube which is used is 1.5 m long and 2.5 cm in diam, with optically sealed Brewster

angle windows. The gases used were helium and neon with a small admixture of argon; the argon shifted the operating wavelength from the normal 1.15 μ to the new transition wavelength. B.B.

A67-24911
IMPROVED ROOM-TEMPERATURE LASER PERFORMANCE IN GaAs DIFFUSED-JUNCTION DIODES.
R. O. Carlson (General Electric Co., Research and Development Center, Schenectady, N.Y.).
Journal of Applied Physics, vol. 38, Feb. 1967, p. 661-668. 23 refs.
Army-supported research.

Significant reduction in room-temperature laser threshold and stimulated emission delay is obtained in diodes made from zinc-diffused waters (850°C, 3 hr in a Zn-As atmosphere) if the single-diffusion process is modified with multiple diffusions, or more controllably, by the addition of a post-annealing step (~900°C in As atmosphere) following the initial diffusion. Incremental sheet-conductivity measurements show the zinc concentration gradient is reduced and etching studies show a lowered dislocation density near the junction after annealing. Without an annealing step, diffused-junction diodes show consistently larger emission delays (observed above ~200°K) than epitaxial-junction diodes made from the same n-type substrates. The deliberate in-diffusion of high copper concentrations causes large delays even at 77°K. However, copper is probably not the center causing delays near room temperature because a mass spectrographic analysis did not reveal higher copper concentrations in diffused-junction wafers than in epitaxial-junction wafers when there was no deliberate copper doping. (Author)

A67-24927 *
MEASUREMENT OF RAY DEVIATIONS IN AN OPTICALLY INHOMOGENEOUS FIELD.
Robert L. Bond, George S. Ballard, and Joseph B. Story (Arkansas, University, Graduate Institute of Technology, Dept. of Electronics and Instrumentation, Little Rock, Ark.).
Journal of Applied Physics, vol. 38, Feb. 1967, p. 907, 908. 7 refs.
Grant No. NsG-713.

Discussion of the use of the hologram to measure the angles through which particular rays are deviated in passing through an optically inhomogeneous field. Without the use of holography, it would be possible to make this measurement only for static systems. Thus, laser holography can be combined with shadowgraphic, schlieren, and interferometric techniques to provide a more detailed study of the field than has previously been possible. M.F.

A67-24931
RADIAL DRIFT VELOCITIES IN THE ARGON ION LASER.
G. N. Mercer, V. P. Chebotayev, and W. R. Bennett, Jr. (Yale University, Dunham Laboratory, New Haven, Conn.).
Applied Physics Letters, vol. 10, Mar. 15, 1967, p. 177-179. 7 refs.
Grants No. AF AFOSR 626-65; No. AF AFOSR 626-67; Contract No. DA-31-124-ARO(D)-124.

Investigation of the measured values of the ion radial drift velocity in an argon ion laser discharge tube. The data were obtained from observation of the spontaneous emission line shapes of ion and neutral transitions from the end and from the side of the discharge. The relationship of the data to various postulated excitation processes is considered. The effect of the radial drift velocities on the observed saturation of the axial drift velocities is also discussed. R.B.S.

A67-24932
CENTRAL TUNING DIP IN A SUBMILLIMETER MOLECULAR LASER.
M. A. Pollack, T. J. Bridges, and A. R. Strnad (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
Applied Physics Letters, vol. 10, Mar. 15, 1967, p. 182, 183. 12 refs.

A central tuning dip (or "Lamb dip") has been observed in the power output of a CW molecular laser operating at 118.6 μ. The collision broadened linewidth was calculated from the shape of the dip. From the dependence of the linewidth on pressure, a radiative lifetime of 0.64 μsec and a pressure broadening (full width) of 10 MHz/torr H_2O can be estimated. Comparisons with published results for OH and H_2O do not yield sufficient information to identify either as the lasing species. (Author)

A67-25072
THE "CLEARING UP" EFFECT IN ZnS(Co) CRYSTALS UNDER THE INFLUENCE OF GIANT PULSES FROM A RUBY LASER.
L. N. Galkin.
(Akademiia Nauk SSSR, Doklady, vol. 170, Sept. 11, 1966, p. 315, 316.)
Soviet Physics - Doklady, vol. 11, Mar. 1967, p. 802, 803. 5 refs
Translation.

A67-25147
EXPERIMENTAL OBSERVATION OF THE INHOMOGENEOUS NATURE OF THE GAIN CURVE OF A HELIUM-NEON LASER [MISE EN EVIDENCE EXPERIMENTALE DU CARACTERE INHOMOGENE DE LA COURBE DE GAIN D'UN LASER HELIUM-NEON].
Daniel Launois (Compagnie Française Thomson-Houston, Laboratoire de Recherches Générales, Bagneux, Seine, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 11, Mar. 13, 1967, p. 868-870.
In French.

Study of a single-mode helium-neon laser used as an analyzer and amplifier of the axial modes of a laser oscillating at several frequencies. Discontinuities in the output power of the single-mode laser are noted; they are regarded as a manifestation of the saturation of an inhomogeneous gain curve. A.B.K.

A67-25148
VARIATION OF THE REFRACTIVE INDEX OF GLASS SUBJECTED TO A FOCUSED LASER BEAM [VARIATION DE L'INDICE DE REFRACTION D'UN VERRE SOUMIS A UN FAISCEAU LASER FOCALISE].
Jean-Claude Buges, Jean-Michel Jego, Alain Terneaud, and Pierre Veyrie (Commissariat à l'Energie Atomique, Centre 5, Service de Documentation, Villeneuve-Saint-Georges, Seine-et-Oise, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 11, Mar. 13, 1967, p. 871-874. 9 refs. In French.

Analysis of the formation of a fracture line in a glass specimen as a result of the focusing of a laser beam. Using a special strioscopic assembly, a variation in the refractive index is found to occur before the formation of a fracture. The power-transmission curve during the laser pulse is found to be similar to that of gases. A.B.K.

A67-25156
CHANGES IN THE CURRENT-VOLTAGE CHARACTERISTICS OF LASERS DURING THE TRANSITION FROM AMPLIFIER TO THE LASER MODES OF OPERATION.
B. I. Gladkii, D. N. Nasledov, and B. V. Tsarenkov (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR).
(Fizika Tverdogo Tela, vol. 8, Nov. 1966, p. 3282-3287.)
Soviet Physics - Solid State, vol. 8, May 1967, p. 2625-2629.
Translation.
[For abstract see issue 04, page 678, Accession no. A67-15132]

A67-25162
MAGNETO-OPTICAL MODULATION OF THE INFRARED RADIATION FROM A GAS LASER.

M. V. Chetkin and V. S. Solomatin (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR).
(Fizika Tverdogo Tela, vol. 8, Nov. 1966, p. 3388-3390.)
Soviet Physics - Solid State, vol. 8, May 1967, p. 2708, 2709. 5 refs
Translation.

A67-25197
NOTE ON A TOROIDAL LASER RESONATOR.
M. Miler (Československá Akademie Věd, Ústav Radiotechniky a Elektroniky, Prague, Czechoslovakia).
Zeitschrift für Naturforschung, Ausgabe A, vol. 22, Feb. 1967, p. 277, 278. 5 refs.

Examination of toroidal lasers with rectangular cut. The modal properties of the field inside the resonator and the optical stability of the beam of rays from the laser were investigated. The advantages of the toroidal resonator with a circular cut are pointed out.
R. B. S.

A67-25198
ACCELERATION OF AN INHOMOGENEOUS PLASMA BY LASER BEAMS [BESCHLEUNIGUNG VON INHOMOGENEN PLASMEN DURCH LASERLICHT].
H. Hora, D. Pfirsch (Institut für Plasmaphysik GmbH, Garching; Max-Planck-Institut für Physik und Astrophysik, Munich, West Germany), and A. Schlüter (Institut für Plasmaphysik GmbH, Garching, West Germany).
Zeitschrift für Naturforschung, Ausgabe A, vol. 22, Feb. 1967, p. 278-280. 13 refs. In German.

Description of the phenomena observed when a high-intensity light beam, such as a laser beam, interacts with a plasma. Through the interaction of the beam with a solid body in a vacuum, oncoming ions received energies of 1 kev and higher. Smear photography was used to record the expansion of the plasma. R. B. S.

A67-25200
TEMPORARY BLEACHING OF DOPED ALKALI-HALOGEN-CRYSTALS WITH A RUBY LASER [TEMPORÄRES BLEICHEN IN DOTIERTEN ALKALIHALOGENIDKRISTALLEN MIT EINEM RUBINLASER].
J. Hingsammer, J. Schwarzmüller, G. Wolfram, and G. Gehrer (München, Technische Hochschule, Physik-Department, Munich, West Germany).
Zeitschrift für Naturforschung, Ausgabe A, vol. 22, Feb. 1967, p. 282-284. 9 refs. In German.

Study of the origin and transformation of color centers in alkali-halogen-crystals through use of the ruby laser. A spectrographic investigation was made on KI, KI:Ba, and KCl:Sr crystals at the temperature of liquid nitrogen. R. B. S.

A67-25209
HETERODYNE DETECTION OF SUB-MILLIMETRE RADIATION.
H. A. Gebbie, N. W. B. Stone (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England), E. H. Putley, and N. Shaw (Ministry of Aviation, Royal Radar Establishment, Great Malvern, Worcs., England).
Nature, vol. 214, Apr. 8, 1967, p. 165, 166. 5 refs.

Discussion of the design and principle of operation of a heterodyne detector for 0.337-mm radiation. An increase in the detectivity of this device is observed. It is pointed out that further improvements both in the maser and in the detectors are required before the performance approaches that of a perfect receiver. M. F.

A67-25295
STUDY OF A TRAVELING WAVE MASER AT 8 MM WAVELENGTH [ETUDE D'UN MASER A ONDE PROGRESSIVE DE 8 MM DE LONGUEUR D'ONDE].
Y. de Coatpont and A. Robert (Compagnie Générale de Télégraphie sans Fil, Département CEPCA, Paris, France).
(Colloque International Récepteurs Micro-ondes à Faible Bruit, Paris, France, May 23-27, 1966, Communication.)
L'Onde Electrique, vol. 47, Feb. 1967, p. 165-177. 13 refs.
In French.
Research supported by the Direction des Recherches et Moyens d'Essais.

Study of a maser which operates in the 8-mm waveband, using the traveling wave arrangement, the active material being a ruby crystal doped with trivalent iron. Push-pull type pumping is carried out in the 4-mm waveband. The applied magnetic field is 10,000 oe. The structure is made unidirectional by the inclusion of a ferrite screen. Between 34 and 36 GHz, a net gain of around 26 db is obtained for a passband of 30 MHz. The noise temperature is less than 50°K. This amplifier, intended to be included in a radiometry receiver, should substantially improve the sensitivity over that of a conventional receiver. F. R. L.

A67-25297
STUDY AND DEVELOPMENT OF A CAVITY MASER FUNCTIONING AT $\lambda = 4$ MM [ETUDE ET REALISATION D'UN MASER A CAVITE FONCTIONNANT A $\lambda = 4$ MM].
A. Molé and M. Soutif (Grenoble, Université, Laboratoire de Physique Générale, Grenoble, France).
(Colloque International Récepteurs Micro-ondes à Faible Bruit, Paris, France, May 23-27, 1966, Communication.)
L'Onde Electrique, vol. 47, Feb. 1967, p. 183-191. 21 refs.
In French.
Research supported by the Direction des Recherches et Moyens d'Essais.

Use of a cavity maser operating at a wavelength of 4 mm as a means of solving the problem of atmospheric absorption. Although because of their simplicity, parametric amplifiers provide the ideal solution at centimeter wavelengths, it is not certain that they can be provided in the field of millimeter waves. A total gain of 20 db was measured for a bandwidth of 150 MHz. F. R. L.

A67-25325 #
WIDTH OF THE GENERATION SPECTRUM OF A RUBY LASER [O SHIRINE SPEKTRA GENERATSII OKG NA RUBINE].
A. M. Sarzhevskii and M. I. Khomich (Akademiia Nauk Belorusskoi SSR, Institut Fiziki, Minsk, Belorussian SSR).
Akademiia Nauk BSSR, Doklady, vol. 11, Feb. 1967, p. 112-114.
In Russian.

Application of an IT-28 interferometer to the measurement of the width of the lasing spectrum of a ruby laser, as a function of pumping power and mirror spacing. It is found that the width of the lasing spectrum is linearly dependent on the pumping power. The value of 0.218 cm^{-1} obtained at a pumping power of 405 joules (which is 1.65 times the threshold pumping power) is found to correlate well with literature data. V. P.

A67-25331 #
A WATER-COOLED MERCURY ARC FOR CONTINUOUS WAVE LASER PUMPING.
T. B. Read (Associated Electrical Industries, Ltd., Central Research Laboratory, Rugby, Warwicks., England).
Journal of Scientific Instruments, vol. 44, Apr. 1967, p. 273, 274.
Research supported by the Ministry of Defence /Navy/.

Description of a dc discharge lamp designed for optimum pumping efficiency of neodymium-doped lasers. The spectral distribution of the emitted radiation is tabulated. The life is over 100 hr at 2 kw or 20 hr at 4 kw input, and it can be operated for short periods at powers up to 6 kw. M. M.

A67-25333 #
AN AUTOMATIC TRACER OF CHARACTERISTIC CURVES FOR OPTICALLY PUMPED LASERS.

J. G. Edwards (General Electric Co., Ltd., Hirst Research Centre, Central Research Laboratories, Wembley, Middx., England).
Journal of Scientific Instruments, vol. 44, Apr. 1967, p. 309-311.

Description of an apparatus for automatically recording photographically points on plots of laser output energy vs excitation energy. A variable pause between shots is possible and the excitation pulse length and energy range can be varied to suit requirements. The detector described measures the fluorescence from a ruby used to integrate laser light. More conventional detectors can be used but may give an increased scatter of points or not hold their absolute calibration. Standard errors of 2% in threshold and slope are obtained with an absolute accuracy to 4%. M. M.

A67-25335
PRODUCTION OF FOURIER HOLOGRAMS WITH THE AID OF A PULSED RUBY LASER.
A. L. Mikaelian, L. N. Razumov, N. A. Sakharova, and Iu. G. Turkov.
(ZHETF Pis'ma v Redaktsiiu, vol. 5, Mar. 1, 1967, p. 148-150.)
JETP Letters, vol. 5, Mar. 1, 1967, p. 119-121. Translation.

Discussion of the use of ruby lasers to obtain Fourier holograms in light reflected from diffusely scattering objects. The use of the Fourier method greatly relaxes the requirements imposed on the resolving power of the photographic emulsions. The experiments discussed show that in order to improve the pulsed holography, it is necessary to increase the spatial coherence of the ruby laser, by producing effective methods of transverse-mode selection and by greatly increasing the resolution of the films, which is of importance also for image noise suppression. M. F.

A67-25336
OPTICAL BREAKDOWN "FIREBALL" IN THE FOCUS OF A LASER BEAM.
G. A. Askar'ian, M. S. Rabinovich, M. M. Savchenko, and V. K. Stepanov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, Mar. 1, 1967, p. 150-154.)
JETP Letters, vol. 5, Mar. 1, 1967, p. 121-124. Translation.

Study showing that the light spark exhibits a feature characteristic of a strong high-temperature explosion, namely the so-called "fireball," which is a strongly ionized region from which a shock wave is detached and moves forward when its ionizing action is noticeably weakened. The fireball (FB) is produced by the shock wave during that period when it exerts the strongest ionizing action (during the first stage, owing to photoionization, the FB front may lead the shock wave front). The FB model is found to explain satisfactorily a large number of phenomena. M. F.

A67-25361
NONLINEAR OPTICAL MATERIALS.
V. S. Suvorov and A. S. Sonin.
(Kristallografiia, vol. 11, Sept.-Oct. 1966, p. 832-848.)
Soviet Physics - Crystallography, vol. 11, Mar.-Apr. 1967, p. 711-723. 63 refs. Translation.

A67-25364 #
ADJUSTMENT OF A GAS LASER SYSTEM [USTAWIENIE UKŁADU OPTYCZNEGO LASERA GAZOWEGO].
Jerzy Biernacki and Henryk Hammer (Polska Akademia Nauk, Instytut Fizyki, Zakład Aparatury Naukowo-Pomiarowej, Warsaw, Poland).
Pomiary, Automatyka, Kontrola, vol. 13, Mar. 1967, p. 138-140. In Polish.

Discussion of the auxiliary equipment and the procedure used to focus the optical elements of the Polish LGO3 He-Ne laser. The two steps of the procedure are (1) the coaxial adjustment of the mirrors at the proper spacing and (2) the adjustment of the tube axis to the optical axis of the mirrors. The procedure is illustrated by photographs and sketches. V. P.

A67-25372
STRENGTHENING OF STEELS WITH LASER BEAMS.
L. I. Mirkin and N. F. Pilipetskii (Moskovskii Gosudarstvennyi Universitet, Nauchno-Issledovatel'skii Institut Mekhaniki, Moscow, USSR).
(Metallovedenie i Termicheskaia Obrabotka Metallov, Apr. 1966, p. 70-72.)
Metal Science and Heat Treatment, Mar.-Apr. 1966, p. 319-321. 7 refs. Translation.

A67-25396 #
ON THE PHOTOIONIZATION OF CESIUM VAPORS BY A LASER BEAM.
Iovitzu Popescu, C. Ghita, and N. Niculescu (Academia Română, Institutul de Fizică, Bucharest, Rumania).
IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, 8TH, STANFORD UNIVERSITY, STANFORD, CALIF., MARCH 28-30, 1967, PRESENTATIONS. [A67-25373 12-25]
Symposium sponsored by the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the American Institute of Aeronautics and Astronautics, and Stanford University.
Rochester, N.Y., University of Rochester, Engineering Aspects of Magnetohydrodynamics, 1967, p. 122, 123. 9 refs. Abridged.

Investigation of the positive ion production during the illumination of a cesium vapor-filled thermionic cell with a coherent light beam at $\lambda = 6943$ Å. The first harmonic of a low-power pink ruby laser is used. The laser beam, of about 6 mm diam, passed through a diaphragm and then through a Jena RG-5 filter to avoid any photoionization due to the exciting xenon flash tube. B. B.

A67-25436 #
SUPPRESSION OF CERTAIN MODES IN THE EMISSION OF A RUBY LASER [PODAVLENIE NEKOTORYKH MOD V IZLUCHENII RUBINOVOGO LAZERA].
V. R. Berezovskii, Sh. Sh. Gvatua, R. N. Kukharskii, and V. V. Mumladze (Akademiia Nauk Gruzinskoi SSR, Institut Kibernetiki, Tiflis, Georgian SSR).
Akademiia Nauk Gruzinskoi SSR, Soobshcheniia, vol. 45, Feb. 1967, p. 333-336. In Russian.

Comparative study of the emission spectrum of a ruby laser consisting of several (five) pieces and the emission spectrum of a laser consisting of a single piece. A tendency toward a decrease in the number of modes is observed during the transition from a solid laser to a multielement laser, as well as a corresponding decrease in the half-width of the emission line. A. B. K.

A67-25437 #
OBSERVATION OF PERIODIC VARIATION OF OSCILLATION MODES IN A He-Ne LASER [NABLIUDENIE PERIODICHESKOGO IZMENENIIA TIPOV KOLEBANII V He-Ne LAZERE].
G. A. Gol'dshtein, A. A. Mikaberidze, V. V. Mumladze, and N. V. Tsotskhalishvili (Akademiia Nauk Gruzinskoi SSR, Institut Kibernetiki, Tiflis, Georgian SSR).
Akademiia Nauk Gruzinskoi SSR, Soobshcheniia, vol. 45, Feb. 1967, p. 337-339. In Russian.

Study of periodic variations of oscillation modes in a He-Ne laser occurring as a result of a continuous increase in the length of the resonator. It is shown that the presence of a second laser, which serves as a passive resonator and transmits only certain modes, makes it possible to observe the process of alternation of modes occurring in the first laser as a result of a continuous change in the length of the active resonator. A. B. K.

A67-25445 #
SPONTANEOUS GENERATION BREAKDOWN IN A RUBY LASER [OB EFFEKTE AVTOSRYVA GENERATSII V RUBINOVOM OPTICHESKOM KVANTOVOM GENERATORE].

V. L. Broude, V. I. Kravchenko, P. P. Pogoretskii, E. N. Sal'kova, and M. S. Soskin (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki, Kiev, Ukrainian SSR).
Akademiia Nauk SSSR, Doklady, vol. 173, Mar. 1, 1967, p. 64-66. 7 refs. In Russian.

Account of the observation of premature generation breakdown in a ruby laser, with inserted 50 to 300-mm layers of benzene, water, glycerin, liquid nitrogen or 30 to 120-mm layers of glass and various synthetic materials. Generation time was substantially shorter in a ruby laser with additional media than in a comparable control laser, and the usual monotonic increase of the time of generation with the increase of the pumping level was disturbed. On the other hand, the time-dependent structure of the generated beam was more ordered and the peak amplitude dispersion was smaller in the experimental laser. The possible usefulness of this effect for laser generation output control is indicated. V. Z.

A67-25446 #
STUDY OF THE HYPERACOUSTIC PROPERTIES OF FLUIDS WITH THE AID OF A HELIUM-NEON LASER [ISSLEDOVANIE GIPERAKUSTICHESKIKH SVOISTV ZHIDKOSTEI S POMOSHCH'IU GELII-NEONOVOGO LAZERA].
L. V. Lanshina, Iu. G. Shoroshev, and M. I. Shakhparonov (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR).
Akademiia Nauk SSSR, Doklady, vol. 173, Mar. 1, 1967, p. 70-72. 8 refs. In Russian.

Note on the determination at 6328 Å with the aid of an He-Ne laser of the velocity of propagation of hypersound in toluene, cyclohexane, acetic acid, acetone, water, aqueous acetone, and aqueous methyl alcohol. The method is based on the analysis of the fine structure of the line of Rayleigh scattering. Its accuracy is ~0.5% for the velocity of hypersound and ~20% for the coefficient of its absorption. The experimental ratios between the integral intensity of the central component of hypersound and the sum of integral intensities of the Mandel'shtam-Brillouin components are compared with ratios calculated by the Landau formula. V. Z.

A67-25454 #
ALIGNMENT CHARACTERISTICS OF AN OPTICAL MASER WITH A CORNER PRISM.
Norio Karube and Eiso Yamaka (Matsushita Research Institute Tokyo, Inc., Kawasaki, Japan).
Japanese Journal of Applied Physics, vol. 6, Mar. 1967, p. 364-374. 9 refs.

Description of gaseous laser oscillations obtained in a modified Fabry-Perot resonator in which one of the plane mirrors was placed with a corner-cube prism. The alignment characteristics of such an optical cavity were measured experimentally. It was found that although the alignment tolerance of the plane mirror lasted a few minutes, the tolerance of the prism alignment exceeded a few degrees. This represented an improvement over a conventional Fabry-Pérot resonator by three orders of magnitude. Some of the basic properties of a corner-cube prism, along with this type of resonator, are described. M. M.

A67-25474
DEVELOPMENT OF THE AUTOMATIC LASER TRACKER.
Brian P. Fitzgerald (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Applied Research Laboratory, Waltham, Mass.).
Society of Motion Picture and Television Engineers, Technical Conference and Equipment Exhibit, 101st, New York, N.Y., Apr. 16-21, 1967, Preprint 101-90. 7 p.
$0.75.
Contracts No. AF 29(600)-5192; No. AF 29(600)-5164.

Description of an automatic laser tracker capable of following a rocket sled traveling at Mach 6 at a closest approach of 1000 ft. In this tracker an electro-optical transmitter-receiver system and a camera platform are combined on a common pedestal mounted in a mobile van, the only moving optical element being a 12-in. plane mirror attached to a two-axis servo-controlled mount. The laser transmitter, the receiving optics, and the cameras are aligned on the same axis and all view the target through the steerable mirror. By keeping the mount inertia small, fast dynamic performance is obtained. A. B. K.

A67-25647
THE OPTICAL RADAR METHOD FOR MEASURING THE PARAMETERS OF THE MOON'S FIGURE AND ORBIT.
Iu. L. Kokurin, V. V. Kurbasov, V. F. Lobanov, V. M. Mozhzherin, A. N. Sukhanovskii, and N. S. Chernykh.
(Kosmicheskie Issledovaniia, vol. 4, May-June 1966, p. 414-426.)
Cosmic Research, vol. 4, May-June 1966, p. 367-377. 12 refs.
Translation.

A67-25696
A LASER INTERFEROMETER AND ITS APPLICATION TO VIBRATION AMPLITUDE MEASUREMENT.
R. A. Ackley (General Dynamics Corp., General Dynamics/Convair, San Diego, Calif.) and S. H. Logue (General Dynamics Corp., General Dynamics/Convair, Laser and Optical Systems Group, San Diego, Calif.).
IN: INSTITUTE OF ENVIRONMENTAL SCIENCES, ANNUAL TECHNICAL MEETING, 13TH, WASHINGTON, D.C., APRIL 10-12, 1967, PROCEEDINGS. VOLUME 1. [A67-25676 12-11]
Mt. Prospect, Ill., Institute of Environmental Sciences, 1967, p. 235-240.

This paper describes two configurations of a laser interferometer that is simpler to operate than most others in that accurate parallelism of components and complex electronics to distinguish fringe direction are avoided. Theoretical accuracies (as high as 10^{-11} in. in some areas) are given. Attainment of these under special laboratory conditions with small shakers is described as well as the problems associated with applying this interferometer to larger shakers. The present success and limitations are given in detail together with proposed modifications to remove these limitations. (Author)

A67-25748
LASER SECOND-HARMONIC-INDUCED STIMULATED EMISSION OF ORGANIC DYES.
B. B. McFarland (Korad Corp., Santa Monica, Calif.).
Applied Physics Letters, vol. 10, Apr. 1, 1967, p. 208, 209. 5 refs.
Contract No. Nonr-4130-(00).

Solutions of several dyes of the fluorescein family have been made to exhibit stimulated emission in the visible when excited by ruby and neodymium second harmonics. Oscillation threshold and conversion efficiencies are given. Depolarization effects in the emission are described. (Author)

A67-25749
SPIN-WAVE INTERACTION WITH A LASER BEAM IN YIG.
S. Wang and G. Thomas (California, University, Electronics Research Laboratory, and Dept. of Electrical Engineering and Computer Sciences, Berkeley, Calif.).
Applied Physics Letters, vol. 10, Apr. 1, 1967, p. 210-212. 8 refs.
Grant No. DA-ARO(D)-31-124-G638.

Experimental results are presented concerning the interaction of a Nd laser beam with spin waves in YIG in the subsidiary absorption region. The microwave power was held below the threshold for spin-wave instability. When hit by a laser beam, the sample showed characteristic magnetoelastic and relaxation oscillations. The same oscillations were observed without the laser beam if the microwave power was raised above the threshold for spin-wave instability. The result provides evidence of spin-wave excitation in YIG by a laser beam. (Author)

A67-25984
SIMPLE GIANT PULSE RUBY LASER OF HIGH SPECTRAL BRIGHTNESS.

G. Magyar (United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Culham Laboratory, Culham, Berks., England).
Review of Scientific Instruments, vol. 38, Apr. 1967, p. 517-519. 12 refs.

Study of a giant-pulse ruby laser switched by a small rotating prism. With the aid of a specially designed resonant reflector and moderate cooling, the laser delivers all its available power (~ 25 Mw) in a spectral width of < 0.01 Å. The device may be used as the oscillator of a high-power amplifying system. R.B.S.

A67-25988
A STUDY OF MULTIPLE SCATTERING OF OPTICAL RADIATION WITH APPLICATIONS TO LASER COMMUNICATION.
R. A. Dell-Imagine (North American Aviation, Inc., Autonetics Div., Anaheim, Calif.).
IN: ADVANCES IN COMMUNICATION SYSTEMS. VOLUME 2. Edited by A. V. Balakrishnan.
New York, Academic Press, Inc., 1966, p. 1-50. 17 refs.
Grant No. AF AFOSR 700-65.

Determination of the significant parameters of multiple-scattered radiation, and their relation to the design of a reliable optical communication system. Scattering is treated theoretically, and it is shown how the current generated by the scattered fields in a photodetector can be computed from the solution of the equation of radiative transfer. The results of a numerical simulation of the equation are given, and the detection of the transmitted waveforms is discussed. M.M.

A67-25990
OPTICAL TECHNIQUES IN COMMUNICATION SYSTEMS.
L. J. Cutrona (Conductron Corp.; Michigan, University, Ann Arbor, Mich.).
IN: ADVANCES IN COMMUNICATION SYSTEMS. VOLUME 2. Edited by A. V. Balakrishnan.
New York, Academic Press, Inc., 1966, p. 107-150. 13 refs.

Brief review of the fundamental principles on which optical computing is based. The use of these techniques and the configurations for performing a number of operations are described. Optics fundamentals are discussed to provide the minimum background necessary for the understanding of the applications of these techniques to communications problems. Fourier transform relationships, linear operations, general features of a communications system, the coding problem, and optical configurations in communication systems are among the subjects treated. M.M.

A67-26015 #
A LASER SOURCE INTEGRATING SPHERE FOR THE MEASUREMENT OF DIRECTIONAL, HEMISPHERICAL REFLECTANCE AT HIGH TEMPERATURES.
G. J. Kneissl, J. C. Richmond (National Bureau of Standards, Washington, D.C.), and J. A. Wiebelt (Oklahoma State University, Stillwater, Okla.).
American Institute of Aeronautics and Astronautics, Thermophysics Specialist Conference, New Orleans, La., Apr. 17-20, 1967, Paper 67-300. 12 p. 6 refs.
Members, $0.75; nonmembers, $1.50.
USAF-supported research.

Evaluation of the high temperature spectral emittance of refractory metals and ceramics by measuring their reflectance accurately at high temperatures. An integrating sphere was used to measure the directional, hemispherical reflectance at temperatures up to 2000°K. The accuracy of the measurement was practically independent of the directional distribution of the reflected flux, which made it possible to measure accurately any material of any surface texture. The source used for this instrument was an He-Ne CW laser operated at 0.6328, 1.15 and 3.39 μ. A narrow bandpass filter, whose peak transmittance coincided with the lasing wavelength, was placed in front of the detector to increase the signal to noise ratio. Since conventional sphere coatings could not be used for this high-temperature integrating sphere, a new sphere coating had to be developed. This coating exhibits a high reflectance at all three wavelengths in question, is a very good diffuser, possesses good mechanical properties, and can be used in a low pressure system. Preliminary data are shown for materials such as graphite, tungsten, and thorium oxide. (Author)

A67-26065
PRODUCTION OF SPECTRA OF MULTIPLY CHARGED IONS BY FOCUSING LASER RADIATION ON A SOLID TARGET.
N. G. Basov, V. A. Boiko, Iu. P. Voinov, E. Ia. Kononov, S. L. Mandel'shtam, and G. V. Sklizkov (Akademiia Nauk SSSR, Fizicheski Institut, Moscow, USSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, Mar. 15, 1967, p. 177-180.)
JETP Letters, vol. 5, Mar. 15, 1967, p. 141-143. 9 refs. Translation.

Investigation of a plasmoid that was produced by the radiation from a Q-switched neodymium-glass laser focused by a lens on an Al or Ca target. The spectral characteristics of the plasmoid are given, and the plasma electron temperature is estimated. V.Z.

A67-26124
PHYSICS OF RAMAN LASERS.
M. L. Bhaumik (Electro-Optical Systems, Inc., Pasadena, Calif.).
American Journal of Physics, vol. 35, Apr. 1967, p. 330-335. 19 refs.
Contract No. AF 33(657)-13801.

Outline of the physics of Raman lasers, covering the gain formula, stimulated and spontaneous Raman scattering, and various types of Raman laser cavities. A simple gain formula for the activity threshold of a spontaneous Raman process is given. The performance of resonator types used in lasers based on stimulated Raman scattering is discussed. V.Z.

A67-26159
EXPERIMENTAL INVESTIGATION OF MULTIWATT ARGON LASERS.
I. Gorog and F. W. Spong (Radio Corporation of America, RCA Laboratories, Princeton, N.J.).
RCA Review, vol. 28, Mar. 1967, p. 38-57. 10 refs.

Experimental determination of the quantitative dependence of the output power of ionized multiwatt argon lasers on discharge current, gas pressure, external axial magnetic field, and discharge-tube bore size. The maximum optical output power measured was 6.86 watts from a 4-mm bore 18-in. tube, and the best efficiency level was 1.02×10^{-3}. The experimental curves are given. V.Z.

A67-26196
DIRECT OBSERVATION OF COLLISION BROADENING AND EFFECT OF RESONANT INTERACTIONS ON GAS-LASER TRANSITIONS.
W. R. Bennett, Jr., V. P. Chebotayev, and J. W. Knutson, Jr. (Yale University, Dunham Laboratory, New Haven, Conn.).
Physical Review Letters, vol. 18, Apr. 24, 1967, p. 688-692. 16 refs.
Grants No. AF AFOSR 626-65; No. AF AFOSR 626-67; Contract No. DA-31-124-ARO(D)-124.

Investigation of the spontaneous emission profiles of the 6328-Å neon transition over typical discharge conditions used in the He-Ne laser. It was found that the collision-broadening cross sections are enormously large ($\gtrsim 10^{-13}$ cm^2) compared with typical gas kinetic cross sections and that there is a very pronounced resonance effect in Ne-Ne collisions as opposed to Ne-He collisions. The method used was that of Ballik et al., in which an exact solution for the transmitted intensity through a tunable Fabry-Pérot interferometer is used to extract the Doppler and Lorentz widths from a spontaneous emission source. M.F.

A67-26221
THEORY OF SEGMENTED LASERS.
Nobuaki Kumagai and Toshiyuki Uegaki (Osaka University, Faculty of Engineering, Osaka, Japan).
Electronics and Communications in Japan, vol. 49, Apr. 1966, p. 220-225. 6 refs. Translation.

Consideration of the oscillation characteristics and special features of doubly segmented laser. It is shown analytically that suppression of unwanted-mode oscillations is possible by suitable partition of a conventional laser. A design to achieve maximum suppression of unwanted modes is discussed. It is also shown that the extreme mode discrimination reported in other experiments cannot be expected to take place by merely segmenting an ordinary laser. R.B.S.

A67-26236 #
MAGNETIC PHENOMENA IN GAS LASERS.
H. de Lang (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands).
(Zeeman Centennial Conference, Amsterdam, Netherlands, Sept. 6-11, 1965, Paper.)
Physica, vol. 33, no. 1, 1967, p. 163-172; Discussion, C. M. Fowler, G. Durand, and N. Spector, p. 172, 173. 8 refs.

Polarization phenomena in gas lasers in the presence of a magnetic field are discussed. Experimental results (including a novel effect at zero field) are explained with the aid of theoretical expresions for the time-dependence of the (quasi-stationary) polarization ellipse of the mode. (Author)

A67-26386 #
A NEGATIVE-ION GAS LASER [GAZOVYI LAZER NA OTRITSATEL'NOM IONE].
B. M. Smirnov.
Akademiia Nauk SSSR, Doklady, vol. 173, Mar. 11, 1967, p. 316-319. 6 refs. In Russian.

Description of a laser scheme in which the atoms in the upper excited state are in thermodynamic equilibrium with the surrounding medium, thus making possible the use of a thermal method of excitation. In the proposed laser scheme the atoms in the upper excited state are formed as a result of a charge exchange between positive and negative ions which makes possible the maintenance of thermodynamic equilibrium between the atoms in the upper excited state and the surrounding gas, while the atomic density in the lower excited state is considerably less than its equilibrium value, owing to radiation. A.B.K.

A67-26388 #
POWERFUL GAS LASERS [MOSHCHNYE GAZOVYE LAZERY].
V. P. Tychinskii.
Uspekhi Fizicheskikh Nauk, vol. 91, Mar. 1967, p. 389-424. 42 refs. In Russian.

Review of Soviet and foreign papers on CO_2 molecular lasers, covering elementary processes in the CO_2 molecule, oscillation level lifetime, competitive energy level transitions, laser amplification, the inversion mechanism, temperature effects, energy relations, and the $CO_2 + N_2 + He$ process. The extremely high levels of power and efficiency obtained with such lasers are noted. V.Z.

A67-26389 #
CO_2 LASERS [OPTICHESKIE KVANTOVYE GENERATORY NA CO_2].
N. N. Sobolev and V. V. Sokobikov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Uspekhi Fizicheskikh Nauk, vol. 91, Mar. 1967, p. 425-454. 81 refs. In Russian.

Review of foreign and some Soviet papers on the CO_2 laser, covering history, development stages, performance, and applications. The subjects specifically discussed include gas discharge tubes and Fabry-Pérot resonators, the spectral composition of continuous radiation, a high-power pulse laser, direct electron excitation of energy levels, upper energy level population, laser relaxation, and laser applications. CO_2, $CO_2 + N_2$, $CO_2 + N_2 + He$, and CO_2 + He laser systems are considered. V.Z.

A67-26398 #
EFFECT OF INTERNAL MODES ON RUBY LASER PERFORMANCE [VPLIV VNUTRISHNIKH MOD NA ROBOTU OPTICHNOGO KVANTOVOGO GENERATORA NA RUBINI].
E. O. Tikhonov and M. T. Shpak (Akademiia Nauk Ukrains'koi RSR, Institut Fiziki, Kiev, Ukrainian SSR).
Ukrains'kii Fizichnii Zhurnal, vol. 12, Mar. 1967, p. 419-424. 9 refs. In Ukrainian.

Analysis of the effect of various types of oscillations on the power and time characteristics of ruby laser radiation, for variable threshold ratios of axial and inner radiation modes. Theoretical conditions for optimum ruby laser performance in terms of maximum and minimum inner-mode generation are realized in experiments. It is found that the generation of inner oscillations is essential in restricting population inversion, especially when polished ruby crystals are used. The use of ruby crystals partially immersed in a medium with a permittivity of 2.0 is suggested to stimulate inner mode generation. V.Z.

A67-26399 #
INVESTIGATION OF A RESONATOR FILLED WITH AN ARTIFICIAL ANISOTROPIC DIELECTRIC [DOSLIDZHENNIA REZONATORA, ZAPOVNENOGO SHTUCHNO ANIZOTROPNIM DIELEKTRIKOM].
L. M. Baranov, M. E. Kovpak, and M. A. Khizhniak (Akademiia Nauk Ukrains'koi RSR, Fiziko-Tekhnichnii Institut, Kharkov, Ukrainian SSR).
Ukrains'kii Fizichnii Zhurnal, vol. 12, Mar. 1967, p. 431-437. 7 refs. In Ukrainian.

Experimental study of the hf properties of laser cavities with anisotropic dielectric fillings. The Q-factor and the shunt resistance are calculated for lasers using cavities containing dielectric TiO_2 disks occupying different portions of the cavity. A technique for making TiO_2 disks with adequate mechanical, electrical, and vacuum properties is described. The experimental results for 35 kw/pulse are in good agreement with theory. V.Z.

A67-26407 *
INTERNAL MODULATION OF LASERS.
Odis P. McDuff (Alabama, University, Dept. of Electrical Engineering, University, Ala.).
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, REGION III CONVENTION, JACKSON, MISS., APRIL 17-19, 1967, PROCEEDINGS. [A67-26404 13-10]
New York, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 121-132. 23 refs.
Grant No. NGR-05-020-103.

Discussion of the coupling of the optical modes of a laser by means of an intracavity time-varying perturbation. Two methods of perturbation are considered. In the first, termed phase perturbation, an element internal to the laser cavity rapidly varies the loss of the resonator. A description of a nonlinear analysis of each method of mode coupling is given, including the effects of atomic lineshape, saturation, and mode pulling as well as the effects of the frequency and amplitude of the perturbation. An intracavity phase perturbation causes a laser to operate either as an "FM oscillator" or as a source which produces a repetitive pulsing in the optical output intensity. The loss modulation produces only this latter "phase locked" oscillation. Experimental results are presented for an argon ion laser with an electro-optical modulator as the intracavity loss perturbing element. Qualitatively, the results are found to compare favorably with the theoretical expectations. (Author)

A67-26512
AUTOMATIC TUNING OF HYDROGEN MASERS.
H. Hellwig and E. Pannaci (U.S. Army, Electronics Command, Electronic Components Laboratory, Fort Monmouth, N.J.).
IEEE, Proceedings, vol. 55, Apr. 1967, p. 551, 552.

Description of the use of beam-intensity modulation based on varying the power of the hydrogen rf-discharge in an automatic tuning system. Two hydrogen masers were tuned automatically and simultaneously. Their beat frequency was measured to have a long term stability of 3×10^{-13}. M. M

A67-26513
TEMPORAL-LINE SHIFT OF PULSED $GaAs_{1-x}P_x$ INJECTION LASER DIODES.
C. J. Magee (Wisconsin, University, Dept. of Electrical Engineering, Madison, Wis.).
IEEE, Proceedings, vol. 55, Apr. 1967, p. 557, 558. 5 refs.
NSF Grant No. GK-198.

Measurement of the time dependence of the coherent emission wavelength shift of $GaAs_{1-x}P_x$ laser diodes during a flat-topped, 240-nsec current pulse. The value of the time dependence was found to agree reasonably well with calculations based on a simple thermal model of the diode which gives a square root of time dependence. M. M.

A67-26522
THE EFFECT OF MULTIPLE ZINC DIFFUSIONS ON THE THRESHOLD AND CW OUTPUT POWER OF GaAs LASERS.
K. M. Hergenrother (Northeastern University, Dept. of Electrical Engineering, Boston, Mass.) and J. E. Ludman (USAF, Office of Aerospace Research, Cambridge Research Laboratories, Bedford, Mass.).
IEEE, Proceedings, vol. 55, Apr. 1967, p. 592.

Comparison of lasers made with various diffusion schedules, and description of a two-step diffusion process which is used in the fabrication of high-power (approaching 3 watts CW at 77°K) high-efficiency (15%) lasers. The mechanism by which the second diffusion leads to good laser junctions 5 to 8 μ deep is not clearly understood. Voltage vs capacitance measurements indicate a small reduction of the impurity gradient in the junction after the second diffusion, but whether this is significant is not clear. A third diffusion with the zinc present does not affect the laser threshold even though the junction is driven to 10 or 12 μ, and a laser made in this fashion is far superior to one made by a single diffusion of 10 to 12 μ. M.M.

A67-26599
AMPLIFICATION OF THE TIME RESOLUTION OF A FLASH SPECTROSCOPY APPARATUS EQUIPPED WITH A SWITCHED LASER [AUGMENTATION DE LA RESOLUTION TEMPORELLE D'UN APPAREIL DE SPECTROSCOPIE PAR ECLAIR EQUIPE D'UN LASER DECLENCHE].
Jean-René Lalanne and Jean-Jacques Piaud (Centre National de la Recherche Scientifique, Institut de Magnétochimie, Pessac, Gironde, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 12, Mar. 20, 1967, p. 939, 940. In French.

Use of light flashes from a rotating disk to diminish the SNR of the detector of a flash spectroscopic apparatus, and to considerably reduce its time constant (about 10 nsec). It is thus possible to observe at room temperature the nonradiative diactivation of the lowest-energy π-π triplet state of acridine in undegassed benzene solution. F.R.L.

A67-26663
RELATIONSHIP BETWEEN SIGNALS AND NOISE IN PHOTON CHANNELS OF PULSE MODULATED OPTICAL COMMUNICATION [RELATIONS ENTRE SIGNAUX ET BRUITS DANS LES VOIES PHOTONIQUES DE COMMUNICATION OPTIQUE A MODULATION D'IMPULSIONS].
V. I. Makkaveev (Leningradskii Elektrotekhnicheskii Institut Sviazi, Leningrad, USSR).
(Société Popov de la Technique Radio et de l'Electronique, Session, Moscow, USSR, June 1966.)
L'Onde Electrique, vol. 47, Mar.-Apr. 1967, p. 503-511. 11 refs. In French.

Discussion of the SNR and the transmission error probability in optical communication channels using lasers and involving pulse modulation. The various types of possible modulation are considered, and the use of one or the other according to the type and the power of the laser employed is examined. F.R.L.

A67-26700
DESIGN AND USE OF AN ULTRAVIOLET LASER.
Donald A. Leonard (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
Laser Focus, vol. 3, Feb. 1967, p. 26-32. 18 refs.

Analysis of the complete profile of the pulsed nitrogen laser. Theoretical considerations and present and potential applications are examined. The Avco model C102 pulsed nitrogen laser is used for the purpose of the study. The advantages of a pulsed nitrogen laser are exemplified by study of the following factors: synchronization characteristics, pulse-to-pulse stability, reliability, peak power, and average power. R.B.S.

A67-26715
A SEARCH FOR THE Λ-DOUBLET TRANSITION IN THE $^2\Pi_{1/2}$, $J = 1/2$ STATE OF OH.
B. Zuckerman, Patrick Palmer, and H. Penfield (Harvard University, Harvard College Observatory, Cambridge, Mass.).
Nature, vol. 213, Mar. 25, 1967, p. 1217, 1218. 8 refs.
NSF-supported research.

Results from the 140-ft telescope of the National Radio Astronomy Observatory, used to evaluate recent radio astronomical investigations of the 18-cm ground-state Λ-doublet transition of the OH radical, which suggest that maser amplification of the radiation is taking place in the interstellar medium. The $^2\Pi_{1/2}$ lines were searched for, but not found, in W3 and W49. The experiment placed upper limits on the intensities of the $^2\Pi_{1/2}$, $J = 1/2$ Λ-doublet lines; the upper limits are 1 to 2% of the observed 18-cm Λ-doublet emission lines. F.R.L.

A67-26724
DEVELOPMENT OF A LASER COMMUNICATION SYSTEM. I.
Michiaki Ito and Teiji Uchida (Nippon Electric Co., Ltd., Central Research Laboratories, Quantum Device Research Laboratory, Laser Section, Tokyo, Japan).
NEC Research and Development, Oct. 1966, p. 75-83. 23 refs.

Description of the development of a laser communication system capable of transmitting a standard black and white television signal. Research with He-Ne gas lasers is discussed featuring extensive application of the spheroidal wave concept and study of the phase-locking phenomenon using a laser with a built-in KDP modulator in the resonator. Conclusions reached regarding focusing and noise level are analyzed. Three methods of light modulation were developed. The electro-optic coefficient r_{63} of KDP crystal rapidly increases as the crystal is cooled down to the Curie temperature. This effect was applied to efficient light modulation. A cascade light modulator was developed as an alternative method. It consists of five glass-separated Z-cut KDP elements with attached electrodes. A third method provides for direct modulation by inserting a calcite prism and a Z-cut KDP crystal and eliminating reflection at discontinuous surfaces. Methods of detection are discussed, and an example of TV transmission equipment is treated. T.M.

A67-26725
DEVELOPMENT OF A LASER COMMUNICATION SYSTEM. II.
Michiaki Ito (Nippon Electric Co., Ltd., Central Research Laboratories, Quantum Device Research Laboratory, Laser Section, Tokyo, Japan).
NEC Research and Development, Oct. 1966, p. 84-88.

Analysis of the behavior in atmosphere of a laser beam modulated for black and white television signal transmission. The behavior of

a laser beam propagating through the atmosphere characterizes the entire system performance. Optimization of design as well as inherent limitations contrasted with microwave counterparts are discussed. The tests which were performed proved satisfactory transmission of a 525-line, 30-frame monochromatic TV signal. The advantages of laser beam transmission over microwave are discussed in terms of signal propagation and distribution, and its relative limitations caused by atmospheric variations and interference are analyzed. The observations revealed that laser communication is satisfactory for distances up to several kilometers and provides reasonable reliability if 30 db for the attenuation margin and a few db for scintillation are assumed. T.M.

A67-26727

SELF-LOCKING OF MODES IN A PASSIVE Q-SWITCHED LASER.

C. A. Sacchi, G. Soncini, and O. Svelto (Milano, Politecnico, Istituto di Fisica, Milan, Italy).

Nuovo Cimento, vol. 48B, Mar. 11, 1967, p. 58-72. 16 refs.

Research supported by the Consiglio Nazionale delle Ricerche.

Presentation of a theory for self-locking of modes in a passive Q-switched laser. Under several assumptions, which are well fulfilled in practice, it is shown that the phases of the oscillating modes are locked together according to one of two relations, depending upon the position of the cell containing the saturable absorber within the cavity. When the first locking relation applies, the output light is constituted by a Q-switched pulse train with a pulse rate equal to the fundamental beat frequency between two adjacent modes of the cavity. When the second locking relation applies, the output light is constituted by a Q-switched pulse train with a pulse rate equal to twice the fundamental beat frequency. The first locking condition is most easily observed when the cell is placed near either one of the two ends of the cavity. The second locking condition is most easily observed when the cell is placed at the center of the cavity. The parameters which influence the locking phenomenon are discussed. A few conclusions of the theory have also been experimentally checked. This theory is in agreement with that developed by Statz and Tang for the case of self-locking due to the nonlinearity of the active material itself. (Author)

A67-26729

GIANT PULSE OPERATION OF A MANY-ELEMENT LASER WITH A COMPOSITE SWITCHING DEVICE.

F. Barocchi (Consiglio Nazionale delle Ricerche, Centro Microonde. Florence, Italy), M. Mancini, and R. Pratesi (Firenze, Università, Istituto di Fisica Superiore, Florence, Italy).

Nuovo Cimento, vol. 48B, Mar. 11, 1967, p. 159-162. 19 refs.

Contract No. AF 61(052)-871.

Summary of the main features of a many-element laser employing a composite Q-switch consisting of a spinning prism and a saturable glass plate. The results are given for experiments in Q-switching, using the spinning prism alone, the saturable plate alone, and a combination of the two. It is concluded that, with very long and highly inverted active materials, it is no longer possible to obtain high-power giant pulses by means of external, even composite, optical shutters - i.e., by merely switching the Q cavity. A.B.K.

A67-26730

ON R.F. DISCHARGE FORMATION IN A He-Ne LASER TUBE.

P. Burlamacchi (Consiglio Nazionale delle Ricerche, Centro Microonde, Florence, Italy).

Nuovo Cimento, vol. 48B, Mar. 11, 1967, p. 171-173. 6 refs.

Results of experimental observations of the mechanism of discharge formation and propagation in a laser tube excited with a pulsed rf voltage under standard operating conditions. A study is made of the light buildup at equidistant points along the discharge tube, and a qualitative description is given of the main processes involved in the growth of the discharge. A.B.K.

A67-26769

A LASER WITH NONRESONANT FEEDBACK.

R. V. Ambartsumian, N. G. Basov, P. G. Kriukov, and V. S. Letokhov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).

(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, Sept. 1966, p. 724-729.)

Soviet Physics - JETP, vol. 24, Mar. 1967, p. 481-485. 8 refs. Translation.

[For abstract see issue 01, page 90, Accession no. A67-10740]

A67-26810

LIGHT-EMITTING SEMICONDUCTORS.

Frederick F. Morehead, Jr. (International Business Machines Corp., New York, N.Y.).

Scientific American, vol. 216, May 1967, p. 108-113, 116, 118-120, 122.

Investigation of electron-exciting mechanisms which can be used to induce luminescence in crystals of semiconducting compounds. The phenomena of incandescence and luminescence are described, and the atomic structure of elementary solids such as germanium is investigated. The p-n junction, the most effective system for injecting minority carriers into a semiconducting material, is discussed, and stimulated emission (lasing) from the diode is investigated. Several uses of solid-state devices as small light emitters are discussed. B.B.

A67-26860

DIFFRACTION ON A RUBY PUMPED BY A STANDING LIGHT WAVE [BEUGUNG AN EINEM MIT STEHENDEN LICHTWELLEN GEPUMPTEN RUBIN].

H. Boersch and H. Eichler (Berlin, Technische Universität, I. Physikalisches Institut, Berlin, West Germany).

Zeitschrift für angewandte Physik, vol. 22, no. 5, 1967, p. 378, 379. 5 refs. In German.

Investigation of the spatial modulation in the populations of the ground and excited state in an optically pumped ruby. A possible application of this spatial modulation is the analysis of the space and time distribution of a laser beam. An experiment is described in which the ruby acts as a diffraction grid for a second light wave. The half-life period, in which the space distribution is equalized, was measured. R.B.S.

A67-27012

PROPOSED RESONATOR FOR AN X-RAY LASER.

W. L. Bond, M. A. Duguay, and P. M. Rentzepis (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).

Applied Physics Letters, vol. 10, Apr. 15, 1967, p. 216-218. 6 refs.

Proposal of a simple scheme for an X-ray laser resonator. A three-dimensional "puckered ring" type arrangement of crystals set at the Bragg angle is involved. A schematic drawing is given showing the low-loss and high-loss polarization eigenmodes. Parameters of three practical geometries for the resonator of an X-ray laser to operate on the copper Kα line are presented. R.B.S.

A67-27013

TWO-PHOTON STEPWISE ABSORPTION IN Er^{3+} DOPED SALTS.

I. Richman (Douglas Aircraft Co., Santa Monica, Calif.) and N. C. Chang (Aerospace Corp., El Segundo, Calif.).

Applied Physics Letters, vol. 10, Apr. 15, 1967, p. 218-221. 6 refs.

Contract No. AF (695)-1001.

The ordinary fluorescence of Er^{3+} in Y_2O_3 and LaF_3 crystals is observed when the crystals are excited with 6328-Å He-Ne laser radiation. From the linear power dependence of the 6800-Å fluorescence and the quadratic power dependence of the 5640- and 3900-Å fluorescence on the 6328-Å excitation, a single-photon excitation for the 6800-Å fluorescence and a double-photon stepwise excitation for the 5640- and 3900-Å fluorescence were proposed.

The calculated photon flux of the 5640-Å fluorescence based on the two-photon stepwise excitation agrees with the estimated observed value. (Author)

A67-27014
TIME EVOLUTION OF PICOSECOND OPTICAL PULSES.
W. H. Glenn and M. J. Brienza (United Aircraft Corp., United Aircraft Research Laboratories, East Hartford, Conn.).
Applied Physics Letters, vol. 10, Apr. 15, 1967, p. 221-224. 6 refs.
USAF Contract No. F 19628-67-C-0075.

A high-speed energy correlation technique has been used to measure the time development of the width of the ultrashort pulses generated by a mode-locked Nd^{+3} glass laser. The laser was simultaneously Q-switched and mode-locked with a saturable absorber and produced a train of approximately 100 ultrashort pulses. It was found that the initial pulses in the train were of the shortest duration and that the pulse width increased from several picoseconds to about 15 psec over the length of the train. The measurement technique and possible mechanisms for this behavior are discussed. (Author)

A67-27015
GENERATION OF COMBINATION TONES BY THE INTERACTION OF ORTHOGONAL OSCILLATIONS IN A GAS LASER.
W. M. Doyle and M. B. White (Philco-Ford Corp., Aeronutronic Div., Newport Beach, Calif.).
Applied Physics Letters, vol. 10, Apr. 15, 1967, p. 224-226.

Derivation of a theoretical expression for the amplitudes of the combination-tones which result from the interaction of orthogonal laser oscillations. Combination-tone generation is found to be highly dependent upon the degree of degeneracy of the atomic energy levels involved and upon the polarization states of the primary oscillations. The theoretical predictions are compared with the results of an experimental study of combination-tone phenomena in He-Ne lasers. R.B.S.

A67-27016
THERMAL EFFECTS IN SEMICONDUCTOR REFLECTIVITY ENHANCEMENT.
Milton Birnbaum, Curtis L. Fincher, and Tom L. Stocker (Aerospace Corp., El Segundo, Calif.).
Applied Physics Letters, vol. 10, Apr. 15, 1967, p. 227-229. 11 refs.
Contract No. AF 04(695)-1001.

Study of semiconductor reflectivity enhancement through use of a pulsed argon ion laser. The time dependence of the enhanced reflectivity showed that the electronhole plasma that produced the reflectivity was thermally generated. The investigations were confined to near threshold intensities to enable study of reflectivity enhancement without the complication of surface damage. R.B.S.

A67-27017
TIME DEPENDENCE OF THE POWER OUTPUT AT 337 μ IN A CN LASER.
Eric Brannen (Western Ontario, University, Dept. of Physics, London, Ontario, Canada) and V. Sochor.
Applied Physics Letters, vol. 10, Apr. 15, 1967, p. 232-234.
Research supported by the National Research Council of Canada and USAF.

The time dependence of the laser output pulse at 337 μ in an acetone and nitrogen gas mixture has been studied using a fast indium antimonide detector. Current pulses from a line-type modulator were varied in length from 2 to 20 μsec with amplitudes from 50 to 180 amp. The start of the laser output pulse occurred after the current pulse in the discharge was over, from 6 to 8 μsec after the end of the current pulse. These results indicate that, for the currents used, population inversion and the achievement of conditions allowing laser action, take from 6 to 8 μsec after the discharge ends to become established. (Author)

A67-27018
MOLECULAR LASER ACTION IN HYDROGEN AND DEUTERIUM HALIDES.
Thomas F. Deutsch (Raytheon Co., Research Div., Waltham, Mass.).
Applied Physics Letters, vol. 10, Apr. 15, 1967, p. 234-236.
15 refs.

Examination of laser action on vibrational-rotational transitions between low lying vibrational levels of hydrogen and deuterium halides formed by chemical reactions in an electrically pulsed discharge. Hydrogen halide wavelengths, lying between 2.7 and 3.3 μ, and DF wavelengths, lying between 3.6 and 4.2 μ, and DF wavelengths, lying between 3.6 and 4.2 μ, are listed and identified. R.B.S.

A67-27029 #
STUDY OF THE PHASE DISTRIBUTION IN A LASER APERTURE BASED ON AN ANALYSIS OF RADIATION IN THE FRESNEL ZONE [ISSLEDOVANIE RASPREDELENIIA FAZ V RASKRYVE LAZERA NA OSNOVE ANALIZA IZLUCHENIIA V ZONE FRENELIA].
A. P. Pichugin and A. V. Chekan.
Radioelektronika, vol. 10, Feb. 1967, p. 143-149. 7 refs. In Russian.

Discussion of the relation between the Fresnel zone field and the field in the circular radiating aperture of a laser. It is shown that the positions of field maximum and field minimum on the normal to the aperture center are functions of the phase distribution in the aperture. Some data are obtained on the phase distribution in a laser aperture from the experimental study of the field amplitude distribution in the Fresnel zone. V. Z.

A67-27080 *
PRECISE ISOTOPE SHIFT MEASUREMENTS USING LINE NARROWING INDUCED BY LASER RADIATION.
R. H. Cordover, P. A. Bonczyk, and A. Javan (Massachusetts Institute of Technology, Physics Dept., Cambridge, Mass.).
Physical Review Letters, vol. 18, May 1, 1967, p. 730-732. 6 refs.
Navy-NASA-supported research.

Application of a line-narrowing effect induced by laser radiation to ultra-precise measurements of isotope shifts for two optical transitions in neon. A brief explanation is given of the origin of this effect, and the application of this effect to the determination of isotope shifts for the 1.15-μ and 0.6-μ transitions in a Ne^{22}-Ne^{20} mixture is illustrated. The splittings due to the isotope effect are completely resolved, and the measured linewidths are analyzed. A.B.K.

A67-27084 *
NONLINEAR THEORY OF THE INTERNALLY LOSS-MODULATED LASER.
Odis P. McDuff (Alabama, University, Dept. of Electrical Engineering, University, Ala.) and Stephen E. Harris (Stanford University, Stanford, Calif.).
IEEE Journal of Quantum Electronics, vol. QE-3, Mar. 1967, p. 101-111. 12 refs.
Grant No. NGR-05-020-103.

The paper presents a detailed nonlinear analysis of the internally loss-modulated laser including the effect of arbitrary atomic lineshape, saturation, and mode pulling. Results of the analysis are in part numerical and include a study of the spectral and time domain behavior of the laser output. The results include a determination of the minimum perturbation strength which is necessary to produce phase locking, peak pulse amplitude, and minimum pulsewidth as a function of perturbation strength, a consideration of the detuned case, and a comparison of AM vs FM type phase locking. Results are compared with the previously obtained linearized solutions of others. (Author)

A67-27086
CaF_2:Dy^{2+} LASERS.
Robert J. Pressley and James P. Wittke (Radio Corporation of America, RCA Laboratories, Princeton, N.J.).
IEEE Journal of Quantum Electronics, vol. QE-3, Mar. 1967, p. 116-129. 22 refs.
Research sponsored by the Radio Corporation of America; Contract No. AF 33(615)-1096.

Discussion of the fabrication and operation of $CaF_2:Dy^{2+}$ lasers. It was found that chemical or electrolytic reduction techniques produce the most stable laser rods. The operation of the laser in a magnetic field is analysed, and three magnetic effects (output coupling and orientation, modulation, and laser stabilization with magnetic feedback) are discussed. By aligning the magnetic field and the laser axis parallel to the crystalline [100] axis, modulation of the laser output can be obtained at rates up to 1 MHz with a modulating field of a few tens of gauss. A technique of cooling the crystal with flowing, nonboiling liquid N_2 permits high-level laser operation near 77°K. Power outputs up to 1.21 watts have been obtained from $CaF_2:Dy^{2+}$ when the crystal is pumped optically with two 1-kw tungsten lamps in a double ellipse. At low modulation frequencies and with high fields, quasi-Q-switched operation was obtained. Q-switching was also observed with an external rotating mirror, which gave a series of pulses of 20-nsec rise time. These did not have the characteristic high power of Q-switched pulses but peak powers of only a few tens of watts.

R.B.S.

A67-27087

MODES IN A DEFORMED LASER RESONATOR.

G. Schaack (Darmstadt, Technische Hochschule, Institut für technische Physik, Darmstadt, West Germany).

IEEE Journal of Quantum Electronics, vol. QE-3, Mar. 1967, p. 130, 131. 7 refs.

Research supported by the Deutsche Forschungsgemeinschaft.

Study of the effects of laser resonator deformations. The variations of the diffraction losses and of the amplitudes and phase distributions of the modes during a pumping pulse are studied. The calculations are based on the measured deformation of a neodymium glass rod pumped in an elliptical cylinder with a linear flashlamp.

R.B.S.

A67-27088

TRANSIENTS IN PLASMA LASERS OPERATING AT $\lambda_0 = 0.6328$ MICROMETER.

Frederick M. Shofner (Tennessee, University, Space Institute, Dept. of Electrical Engineering, Tullahoma, Tenn.).

IEEE Journal of Quantum Electronics, vol. QE-3, Mar. 1967, p. 131, 132.

Investigation of three types of representative transient performance data for a He-Ne plasma laser operating at 0.6328 μm. Long-term thermal transients, short-term transients, and transients observed in the case of a delay in the radiation intensity when the input waveform is a step in the discharge current are discussed.

R.B.S.

A67-27089

THE 5401-Å PULSED NEON LASER.

Donald A. Leonard (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).

IEEE Journal of Quantum Electronics, vol. QE-3, Mar. 1967, p. 133-135. 12 refs.

Brief analysis of experimental studies of a pulsed neon laser. It is shown how these experimental results may be predicted theoretically. The laser operates on the $2p_1 \rightarrow 1s_4$ transition of neon at 5401 Å and is one member of a class of self-terminating pulsed gas lasers that includes molecular nitrogen, copper, and lead. Plots are given depicting laser output power vs neon pressure, laser efficiency vs the ratio of initial capacitor voltage to electrode separation, and current density, plasma resistivity, electron temperature, input power density, and laser output saturation power density vs time.

R.B.S.

A67-27227

SOME EXPERIMENTAL RESULTS OBTAINED WITH A C-BAND RUBY MASER CONSISTING OF QUARTER-WAVE-COUPLED TRANSMISSION CAVITIES [QUELQUES RESULTATS EXPERIMENTAUX OBTENUS AVEC UN MASER BANDE C A RUBIS CONSTITUE DE CAVITES EN TRANSMISSION COUPLEES EN QUARTS DE LONGUEUR D'ONDES].

J. C. Jézéquel (Centre National d'Etudes des Télécommunications, Centre de Recherches de Lannion, Lannion, Côtes-du-Nord, France).

Revue de Physique Appliquée, vol. 2, Mar. 1967, p. 20-22. In French.

Description of the design and performance of a maser with two synchronous symmetrical quarter-wave-coupled cavities. The results obtained show that the gain-frequency curve is symmetrical with respect to midband frequency, and that the amplitude of the valley is less than 3 db only for very weak amplifications. Considerations concerning the operating point chosen for the ruby material are included.

M.F.

A67-27229

PHOSPHATE GLASSES - NEW LASER MATERIALS [LES VERRES PHOSPHATES - NOUVEAUX MATERIAUX LASER].

O. K. Deutschbein, C. C. Pautrat, and I. M. Svirchevsky (Centre National d'Etudes des Télécommunications, Département Physique, Chimie, Métallurgie, Issy-les-Moulineaux, Seine-et-Oise, France).

Revue de Physique Appliquée, vol. 2, Mar. 1967, p. 29-37. 18 refs. In French.

Army-supported research.

Study of the absorption and fluorescence characteristics of 500 samples of Nd-doped phosphate glasses. Absorption and fluorescence spectra of phosphate glasses are sharper than those of silicate, borate, germanate, and aluminate glasses. The lifetime is about 280 μsec. Laser rods of phosphate glasses have thresholds of 1.02 joule and 720 watts in semicontinuous operation at room temperature; these thresholds are markedly lower than those of other glasses.

M.F.

A67-27230

STUDY OF THE EFFECTIVENESS OF THE COUPLING BETWEEN A LIGHT SOURCE AND THE ACTIVE MEDIUM IN AN OPTICALLY PUMPED LASER [ETUDE DE L'EFFICACITE DU COUPLAGE ENTRE LA SOURCE LUMINEUSE ET LE MILIEU ACTIF DANS UN LASER A POMPAGE OPTIQUE].

Pierre Brun and Jeanine Bonamy (Rennes, Université, Faculté des Sciences, Rennes, France).

Revue de Physique Appliquée, vol. 2, Mar. 1967, p. 38-44. 8 refs. In French.

Comparison of the efficiencies of two pumping schemes for pulsed optical masers. The lamp is assumed to be a radiator having a Lambert radiation pattern. It is found that the elliptical configuration requires less energy to reach threshold and gives the best energy conversion efficiency above threshold.

M.F.

A67-27237

SCANNING WITH LASERS.

Robert A. Myers (International Business Machines Corp., Thomas J. Watson Research Center, Yorktown Heights, N.Y.).

International Science and Technology, May 1967, p. 40-46, 50, 51.

Analysis of laser light deflecting methods with a description of a new kind of laser resonator, the scanlaser, which combines features of the laser and the cathode-ray tube. Techniques of deflecting laser light which are now possible in the laboratory are described using electron beams, electro-optic crystals, and acoustic cells. The principles of an optical phased array are discussed together with its commercial limitations. In the electron-beam scanlaser, a birefringent plate in the resonator rotates polarized light about 10° for all modes. Then the light falls on an end mirror which has two coatings. Those modes not focused on the point where the electron beam has deposited its charge are reflected back through the plate, where the polarization is reflected a further 10°. When this light is passed back through the polarizer much of it is absorbed and the loss is large enough to prevent laser action. By generating the light with a laser, as much is obtained as the laser can provide and by deflecting the electron beam instead of the light, the question of "deflecting" the photon is avoided.

T.M.

A67-27288 #
INTERFERENCE EFFECTS IN THE FAR-FIELD PATTERNS OF SEMICONDUCTOR DIODE LASERS.
Ch. Deutsch (Bern, Universität, Institut für angewandte Physik, Berne, Switzerland).
Physics Letters, vol. 24A, Apr. 24, 1967, p. 467, 468.

Demonstration that part of the far-field interference pattern of GaAs lasers is caused by light diffracted from the back mirror and transmitted through the n-region. The effect can be eliminated by roughening the n-type side of the front mirror. Near-field and far-field patterns and densitometer tracings are shown. (Author)

A67-27289 * #
THEORY FOR THE POLARIZATION OF THE FOUR COSMIC OH 18-CM LINES.
C. V. Heer and R. A. Settles (Ohio State University, Dept. of Physics, Columbus, Ohio).
Physics Letters, vol. 24A, Apr. 24, 1967, p. 484, 485. 6 refs.
Grant No. NsG-552.

Results of a theoretical study of the states of polarization in an OH maser amplifier. These results are used to predict the anomalous polarization of the four cosmic OH 18-cm lines. The conclusions reached require that the magnetic field or Zeeman splitting in the source must be less than the saturated width of the line - i.e., that $B < 10^{-6} \Delta\omega_S$ gauss. Unless collision broadening is appreciable or the magnetic field experienced by an atom changes during the collision lifetime, magnetic fields less that 10^{-10} gauss are required. R.B.S.

A67-27345
DEVELOPMENT OF A RING LASER FOR POLARIMETRIC MEASUREMENTS.
H. J. Raterink, H. v. d. Stadt (Central Organization for Applied Scientific Research and Delft, Technological University, Institute of Applied Physics, Delft, Netherlands), C. H. F. Velzel (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands), and G. Dijkstra (Utrecht, Rijksuniversiteit, Utrecht, Netherlands).
Applied Optics, vol. 6, May 1967, p. 813-820. 18 refs.
Research supported by the Nederlandse Organisatie voor Zuiver Wetenschappelijk Onderzoek.

Description of a method for the measurement of small optical rotations by using a ring laser of special design. The proposed instrument could be used, for example, to measure small optical rotations in the near IR, caused by vibration bands of organic substances. The development of the ring laser is discussed. A general theory concerning the states of polarization of a laser with an anisotropic cavity is presented. The dynamic behavior of the state of polarization, as a function of an axial magnetic field, in cavities with linear and circular anisotropies is analyzed. This analysis has led to two methods of polarimetric measurements, which are discussed in detail. The experimental setup is given. (Author)

A67-27346
OPTICAL PATH-LENGTH DIFFERENCE EFFECTS IN PHOTOMIXING WITH MULTIMODE GAS LASER RADIATION.
J. W. Foreman, Jr. (Brown Engineering Co., Inc., Research Laboratories, Huntsville, Ala.).
Applied Optics, vol. 6, May 1967, p. 821-826. 10 refs.

It has been widely observed that when a multimode gas laser is employed in photomixing experiments, the heterodyne signal amplitude depends on the optical path length difference between the paths traversed by the two light beams. In this paper, a simple phenomenological model of multimode gas laser radiation is used to calculate the dependence of the heterodyne signal amplitude on optical path length difference for various numbers of oscillating axial modes in a multimode gas laser. The results have important implications for the design of optical heterodyne receivers. (Author)

A67-27347
INTERFEROMETRY OF RESONATOR MODES IN SUBMILLIMETER WAVE LASERS.
P. Schwaller, H. Steffen, J. F. Moser, and F. K. Kneubühl (Eidgenössische Technische Hochschule, Laboratorium für Festkörperphysik, Zurich, Switzerland).
(EUCHEM, Far-Infrared Conference, Culham, England, Sept. 12-16, 1966, Paper.)
Applied Optics, vol. 6, May 1967, p. 827-829. 20 refs.
Research supported by the Eidgenössische Kommission zur Förderung der Forschung.

Comparison of the theory of Bergstein and Schachter on modes occurring in resonators with low Fresnel numbers with the experimental data obtained by laser resonator interferometry. The influence of the tilt of a resonator mirror on the intensity of the laser emission is measured for different modes. M.F.

A67-27348
LIGHT SCATTERING BY LASER MIRRORS.
Richard Blazey (Sperry Rand Corp., Sperry Gyroscope Co., Electro-optics Group, Great Neck, N. Y.).
Applied Optics, vol. 6, May 1967, p. 831-836.

Application of the Beckmann theory of scattering to laser mirrors. It is shown that the theory correctly predicts the wavelength dependence of scattering profiles. The theory can be used to obtain numbers (σ and T) for a laser mirror which describe its scattering characteristics. Scattering measurements made on eleven laser mirrors are presented. (Author)

A67-27349
SOME FACTORS AFFECTING THE PUMPING EFFICIENCY OF OPTICALLY PUMPED LASERS.
J. G. Edwards (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England).
Applied Optics, vol. 6, May 1967, p. 837-843. 14 refs.

Description of a conventional pumping system of a reflecting linear ellipse with the flash tube and laser crystal at the foci. Experimental evidence relating to the behavior of xenon flash tubes at various times during a flash is presented, together with a possible ionic mechanism explaining the result. The pumping efficiency of a typical arrangement is calculated with consideration of the following factors: (1) conversion of electrical energy to radiated energy by the flash tube; (2) absorption in the flash tube walls; (3) cavity geometry; (4) fraction of the energy incident on it which is usefully absorbed by the crystal; and (5) the effect of unabsorbed light of various wavelengths returning to the flash tube knowing the absorptivity of the discharge. The predicted pumping efficiency is compared with experimental values, and possible means of increasing it are discussed. M.F.

A67-27350
TRANSVERSE MODE STRUCTURE IN UNSTABLE OPTICAL CAVITIES.
D. C. Sinclair and T. H. E. Cottrell (Rochester, University, College of Engineering and Applied Science, Institute of Optics, Rochester, N. Y.).
Applied Optics, vol. 6, May 1967, p. 845-849. 10 refs.
Army-supported research.

Experimental investigation of the characteristics of unstable optical cavities, using a pulsed argon laser. The amplitude and phase distribution in the transverse modes of unstable cavities, as well as the characteristics of the output beam, are studied. The experimental results are in qualitative agreement with existing theory. It is also demonstrated that an unstable cavity can be used to provide variable output coupling for a laser. (Author)

A67-27351
RECORDING PARAMETERS OF SPATIALLY MODULATED COHERENT WAVEFRONTS.

A. A. Friesem, A. Kozma, and G. F. Adams (Michigan, University, Institute of Science and Technology, Willow Run Laboratories, Radar and Optics Laboratory, Ann Arbor, Mich.).
Applied Optics, vol. 6, May 1967, p. 851-856. 8 refs.
Research sponsored by the Holotron Corp.

Study of various parameters of recording spatially modulated coherent light, with particular emphasis on the parameters related to constructing holograms. These include the ratio of the reference beam's intensity to that of the signal beam, the offset angle, the film's transfer characteristic, and the recording wavelength. Experimental results were obtained by recording interference patterns on high-resolution film using the 6328-Å line of the He-Ne laser. The bias level of the interference pattern was varied so as to vary the operating point on the curve representing the film's amplitude transmittance vs exposure characteristics. The percent modulation and the spatial frequency were also varied at each of the operating points. Interference patterns were recorded, using the 4880 and 5145-Å lines from the argon laser. From these data, the optimum bias level and the ratio of the signal beam to the reference beam for recording interference patterns are determined. The modulation transfer function of the film can also be determined. M.F.

A67-27364 #
APPLICATIONS OF GAS LASERS [POUŽITÍ PLYNOVÝCH LASERŮ].
Z. Veselá (Československá Akademie Věd, Ústav Přístrojové Techniky, Brno, Czechoslovakia).
Jemná Mechanika a Optika, vol. 12, Apr. 1967, p. 118-120, 126.
In Czech.

Description of the properties of gas lasers which make them useful in physics, chemistry, and optics, and a discussion of their application in those fields. The use of gas lasers in holography, crystallography, spectrometry, and measurement is reviewed. T.M.

A67-27485
LINEWIDTHS OBSERVED IN A ZEEMAN SCANNED LASER AMPLIFIER.
David F. Hotz (Fresno State College, Physics Dept., Fresno, Calif.).
Physica, vol. 33, no. 3, 1967, p. 746-754. 8 refs.

The phenomena of gain narrowing and saturation broadening of the Doppler broadened 3.39-μ neon line have been observed in stimulated emission. The observed frequency profile of the unsaturated gain for plane polarized input is in good agreement with previously derived expressions for the narrowed linewidth so long as the output is not polarization analyzed. In this case, the gain linewidth is narrowed to one third the Doppler width for the highest gain obtained. Plane polarization analysis of the amplified beam yields even further narrowing to 15% of the Doppler width and is understood by a theory of gain narrowing due to Corney. Although the reported data are of insufficient accuracy to determine the radiative linewidth of the transition, an upper bound on the radiative width is estimated to be 36 MHz or less. (Author)

A67-27609 #
A LASER RADAR FOR ATMOSPHERIC STUDIES.
B. R. Clemesha, G. S. Kent, and R. W. H. Wright (West Indies, University, Kingston, Jamaica).
Journal of Applied Meteorology, vol. 6, Apr. 1967, p. 386-395. 7 refs.
Grant No. AF AFOSR 616-64.

The paper describes equipment designed to observe variations in atmospheric density at heights up to 65 km by measuring the intensity of light back-scattered from a laser beam. The basic theory of the technique is briefly described, and an expression is derived for the sensitivity of the laser radar. The design of the equipment is then discussed from the point of view of optimization of the equipmental parameters for maximum sensitivity, with a view to obtaining measurements at the greatest possible height. The paper continues with a description of the actual equipment, a discussion of problems encountered in its application, and the methods used to overcome these problems. Finally, a very brief description is given of the results obtained with the laser radar. (Author)

A67-27628 #
FORMATION OF A LONG SPARK IN AIR UNDER THE EFFECT OF WEAKLY FOCUSED LASER RADIATION [OBRAZOVANIE DLINNOI ISKRY V VOZDUKHE POD VOZDEISTVIEM SLABO SFOKUSIROVANNOGO IZLUCHENIIA LAZERA].
N. G. Basov, V. A. Boiko, O. N. Krokhin, and G. V. Sklizkov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Akademiia Nauk SSSR, Doklady, vol. 173, Mar. 21, 1967, p. 538-541. 13 refs. In Russian.

Investigation of the dynamics of breakdown as a function of the space-time structure of laser radiation. The laser used in the experiments employed a neodymium-glass crystal 15 mm in diameter and 240 mm long. Q-switching was performed with the aid of a Kerr cell with two polarizers. The structure of the radiation in the near and far field is studied by linear scanning. The results are used to derive a formula for the mean rate of propagation of the spark beyond the focal field. V. P.

A67-27629 #
MEANS OF INCREASING THE Q-FACTOR OF THE RESONATOR CAVITY OF A NEODYMIUM LASER [OB ODNOI VOZMOZHNOSTI UVELICHENIIA DOBROTNOSTI REZONATORA NEODIMOVOGO OPTICHESKOGO KVANTOVOGO GENERATORA].
O. N. Voron'ko, N. A. Kozlov, A. A. Mak, B. G. Malinin, and A. I. Stepanov.
Akademiia Nauk SSSR, Doklady, vol. 173, Mar. 21, 1967, p. 542, 543. 6 refs. In Russian.

Experimental investigation showing that the diffraction losses in a resonator cavity can be decreased by proper thermal deformation of a neodymium-glass crystal due to pumping with periodic pulses. It is found that pumping at a frequency of several cycles per second produces a steady temperature gradient in the (water-cooled) rod, which leads to an axisymmetric spherical deformation of the rod. V. P.

A67-27720
RECRYSTALLIZATION OF THIN SEMICONDUCTOR FILMS BY EXPOSURE TO LASER RADIATION.
V. P. Zakharov, Iu. A. Tsvirko, and V. N. Chugaev.
(Akademiia Nauk SSSR, Doklady, vol. 170, Oct. 11, 1966, p. 1056-1058.)
Soviet Physics - Doklady, vol. 11, Apr. 1967, p. 899-901. Translation.

A67-27771 #
THE DETERMINATION OF THE WORKING REGIME OF GAS LASERS.
M. Kutík (Československá Akademie Věd, Ústav Vakuové Elektroniky, Prague, Czechoslovakia).
IN: CZECHOSLOVAK CONFERENCE ON ELECTRONICS AND VACUUM PHYSICS, 3RD, PRAGUE, CZECHOSLOVAKIA, SEPTEMBER 23-28, 1965, TRANSACTIONS. [A67-27747 14-25]
Conference sponsored by Charles University and the Czechoslovak Academy of Sciences.
Edited by Libor Patý.
Prague, Academia, 1967, p. 679-686. 8 refs. In German.

Derivation of the fundamental relations for the amplification of a laser gas-discharge tube (without resonator). The theoretical analysis is performed especially from the point of view of the intensity of the stimulating radiation. The theoretical results are verified by experimental measurements. The theory is applied to the optimalization of operating conditions of the same tube working as an oscillator. R. B. S.

A67-27772 #
DIRECT MODULATION OF THE He-Ne GAS LASER.
Miroslav J. Hyťha and Martin R. Červeňan (Institute of Radiocommunications, Prague, Czechoslovakia).
IN: CZECHOSLOVAK CONFERENCE ON ELECTRONICS AND VACUUM PHYSICS, 3RD, PRAGUE, CZECHOSLOVAKIA, SEPTEMBER 23-28, 1965, TRANSACTIONS. [A67-27747 14-25]
Conference sponsored by Charles University and the Czechoslovak Academy of Sciences.
Edited by Libor Páty.
Prague, Academia, 1967, p. 687-694.

Theoretical analysis of the processes associated with direct modulation of the He-Ne laser with rf excitation, operated on a wavelength of 11,523 Å. Kinetic equations are presented describing the transition processes occurring in the active medium of the laser. The primary stimulus for processes occurring in the gas laser is represented in the equations by the function $n_e(t)$ - i.e., the number of free electrons which primarily by means of collisions excite the He atoms into the metastable states thus effecting the resonant energy transfer into the Ne(2s). The increased number of electrons is proportional to the rf power. The method used has no general validity since it is based on conditions of low modulation depth. This assumption has been made because it complied with the experimental possibilities and because it made it possible to linearize the system of differential equations which are difficult to solve otherwise. All possible phenomena occurring in the active medium are introduced in the equations. The results indicate that it is improbable that direct modulation could be used for a broader frequency range than the region of acoustic frequencies. T.M.

A67-27775
REFRIGERATION MEANS AND DESIGN CONSIDERATIONS FOR COOLING MASERS AND PARAMETRIC AMPLIFIERS.
W. H. Hogan (Arthur D. Little, Inc., Cambridge, Mass.).
IN: LOW-TEMPERATURE REFRIGERATION FOR MICROWAVE SYSTEMS; PROCEEDINGS OF A COLLOQUIUM ON LOW-NOISE MICROWAVE AMPLIFIERS AND LOW-TEMPERATURE REFRIGERATION MEANS, FRANKFURT AM MAIN, WEST GERMANY, APRIL 28, 29, 1966. [A67-27774 14-09]
Colloquium sponsored by Arthur D. Little, Inc.
Edited by W. H. Hogan and Gustav Klipping.
Cambridge, Mass., Boston Technical Publishers, Inc., 1967, p. 13-44. 8 refs.

Discussion of design considerations pertaining to miniature (less than 10 watts) cryogenic refrigeration systems. Fluid-expansion refrigeration cycles are described, and thermodynamic and efficiency considerations are investigated. Refrigerant contamination is studied, and design and construction considerations of cooling microwave components are reviewed. B.B.

A67-27776
ULTRA-LOW-NOISE RECEPTION USING MASERS AND COOLED PARAMETRIC AMPLIFIERS.
Seymour Okwit (Cutler-Hammer, Inc., Airborne Instruments Laboratory Div., Deer Park, N.Y.).
IN: LOW-TEMPERATURE REFRIGERATION FOR MICROWAVE SYSTEMS; PROCEEDINGS OF A COLLOQUIUM ON LOW-NOISE MICROWAVE AMPLIFIERS AND LOW-TEMPERATURE REFRIGERATION MEANS, FRANKFURT AM MAIN, WEST GERMANY, APRIL 28, 29, 1966. [A67-27774 14-09]
Colloquium sponsored by Arthur D. Little, Inc.
Edited by W. H. Hogan and Gustav Klipping.
Cambridge, Mass., Boston Technical Publishers, Inc., 1967, p. 45-87. 16 refs.

Discussion of unique features of maser and parametric amplifier receiver configurations, limited to cryogenically cooled systems. General low-noise considerations are studied, and aspects of ultra-low-noise amplifiers are investigated. Amplifier characteristics are described, and a comparative tabulation is given of microwave traveling-wave maser and parametric amplifier characteristics. B.B.

A67-27777
MASERS FOR SATELLITE COMMUNICATION.
J. J. Degan (Bell Telephone Laboratories, Inc., Allentown, Pa.).
IN: LOW-TEMPERATURE REFRIGERATION FOR MICROWAVE SYSTEMS; PROCEEDINGS OF A COLLOQUIUM ON LOW-NOISE MICROWAVE AMPLIFIERS AND LOW-TEMPERATURE REFRIGERATION MEANS, FRANKFURT AM MAIN, WEST GERMANY, APRIL 28, 29, 1966. [A67-27774 14-09]
Colloquium sponsored by Arthur D. Little, Inc.
Edited by W. H. Hogan and Gustav Klipping.
Cambridge, Mass., Boston Technical Publishers, Inc., 1967, p. 88-98.

Description of maser amplifier operation. A traveling-wave maser system developed as a low-noise ground-station receiving facility is discussed. The system has a 50-Mc instantaneous bandwidth tunable over a 150-Mc band, bandwidth control and tuning being accomplished externally by a superconducting magnet. The maser and the superconducting magnet are designed to operate in liquid helium at 4.2°K. B.B.

A67-27778
OPERATIONAL USE OF A 1.5°K OPEN-CYCLE COOLING SYSTEM FOR A MASER AMPLIFIER.
H. N. Daglish (General Post Office, Research Station, London, England).
IN: LOW-TEMPERATURE REFRIGERATION FOR MICROWAVE SYSTEMS; PROCEEDINGS OF A COLLOQUIUM ON LOW-NOISE MICROWAVE AMPLIFIERS AND LOW-TEMPERATURE REFRIGERATION MEANS, FRANKFURT AM MAIN, WEST GERMANY, APRIL 28, 29, 1966. [A67-27774 14-09]
Colloquium sponsored by Arthur D. Little, Inc.
Edited by W. H. Hogan and Gustav Klipping.
Cambridge, Mass., Boston Technical Publishers, Inc., 1967, p. 99-110.

Description of an open-cycle cooling system for a maser amplifier used at a satellite communication ground station in southwest England. The maser is cooled by immersion in a liquid helium bath with coaxial leads carrying the input and output signals and can be tilted with the whole antenna structure through more than 90° of elevation movement without loss of refrigerant. B.B.

A67-27779 *
AN OPERATIONAL 4.2°K MASER SYSTEM.
W. H. Higa (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.).
IN: LOW-TEMPERATURE REFRIGERATION FOR MICROWAVE SYSTEMS; PROCEEDINGS OF A COLLOQUIUM ON LOW-NOISE MICROWAVE AMPLIFIERS AND LOW-TEMPERATURE REFRIGERATION MEANS, FRANKFURT AM MAIN, WEST GERMANY, APRIL 28, 29, 1966. [A67-27774 14-09]
Colloquium sponsored by Arthur D. Little, Inc.
Edited by W. H. Hogan and Gustav Klipping.
Cambridge, Mass., Boston Technical Publishers, Inc., 1967, p. 111-125.

Description of traveling-wave masers operating in closed-cycle refrigerators used as low-noise preamplifiers at six stations for receiving the picture transmissions of Mars from Mariner 4. The final Mariner 4 picture transmissions occurred at 8 bits per sec at 1.5 AU. Noise temperature contributions of the various system elements are tabulated, and the system design, installation, and operation are discussed. B.B.

A67-27799
GAS LASERS.
C. G. B. Garrett (Bell Telephone Laboratories, Inc., Optical Electronics Research Dept., New York, N.Y.).
New York, McGraw-Hill Book Co., 1967. 160 p. 184 refs.
$10.95.

The origin, development, properties and construction of gas lasers are treated in this book. The origin of optical gain in the various elementary processes occurring in a gas discharge is considered, and the interaction between the gaseous amplifying medium

and the optical cavity is discussed. The mechanisms of specific laser systems are outlined, and detailed descriptions are given of helium-neon, argon-ion, carbon dioxide, and far-IR lasers. Laser construction methods are explained, with details being provided on tubes, electrodes, windows, mirrors, and auxiliary apparatus. Among the properties of the emerging laser beam described are power output, directional distribution, phase and amplitude fluctuations, effects of intracavity modulation, frequency and amplitude stabilization, Q switching, and the application of magnetic fields.

B.B.

A67-27831 #

GaAs LASER PUMPED BY RUBY LASER.

Iwao Kitazima and Chiyoe Yamanaka (Osaka University, Faculty of Engineering, Osaka, Japan).

Japanese Journal of Applied Physics, vol. 6, Apr. 1967, p. 549, 550.

Description of a laser action obtained in a p-type GaAs crystal excited by a Q-switched ruby laser at liquid-nitrogen temperature. The dependence of the GaAs total light output on the incident ruby-laser intensity is shown. The threshold incident power was 0.3 Mw when the size of the focused beam was about 0.1 cm^2. At threshold power the photon yield was two orders smaller than that of the injection laser. It is shown that the emission spectrum below the threshold has a line width of about 130 Å at 8400 Å, which was quite similar to that of the diode emission. As the incident light increased, the linewidth of the GaAs emission began to narrow to about 15 Å, and the spectral peak shifted to the longer wavelength by about 35 Å. It is noted that this spectral shift may be due to the band shrinkage caused by the production of high-density electron-hole pairs, as well as to the heating effect. In these p-type GaAs crystals, the spectral shift due to the Burstein effect for both the conduction and valence bands seems to be masked by the above-mentioned effects.

M.M.

A67-27952

ON THE LINEWIDTH OF ELECTROMAGNETIC RADIATION IN EQUILIBRIUM WITH AN OPTICAL CAVITY.

M. Bertolotti, D. Sette, and F. Wanderlingh (Roma, Università, Istituto di Fisica; Consiglio Nazionale delle Ricerche, Gruppo Nazionale di Struttura della Materia, Rome, Italy).

Nuovo Cimento, vol. 48B, Apr. 11, 1967, p. 301-315. 12 refs.

Study of the process by which electromagnetic radiation attains equilibrium in a laser cavity. The expression of the linewidth is derived and the influence of mirror motion on the broadening is examined. The case of thermal motion is treated in detail.

R.B.S.

A67-28023

AUTOMATED INTERCONNECTION PROCESSES FOR SEMICONDUCTOR INTEGRATED CIRCUIT SLICES.

C. P. Sandbank (International Telephone and Telegraph Corp., Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England), T. M. Jackson, and A. D. Brisbane.

IN: INTEGRATED CIRCUITS; CONFERENCE, EASTBOURNE, SUSSEX, ENGLAND, MAY 2-4, 1967, PAPERS. [A67-28011 14-09]

Conference sponsored by the Electronics Division of the Institution of Electrical Engineers, the Institution of Electronic and Radio Engineers, and the United Kingdom and Republic of Ireland Section of the Institute of Electrical and Electronics Engineers.

London, Institution of Electrical Engineers (IEE Conference Publication No. 30), 1967, p. 181-191. 5 refs.

Review of interconnection processes for semiconductor integrated-circuit slices, describing the interconnection of standard integrated circuits on a slice and a cellular substrate approach in which the standardization is done at component level. The substrate is fabricated using planar techniques, the processed slice consisting of a regular array of electrically isolated cells, each capable of performing the function of a transistor, diode, resistor, or crossover. The gas laser, within its light wavelength limitations, is described as an alternative to electron beams for thermal micromachining. Machining is performed by the use of a tape-controlled micropositioning table, which carries the target substrate at the focal point of the laser lens. The operation of the laser and the micropositioner are described. Photolithographic preparation of the laser-machined mask is discussed. A method of direct localized deposition of material onto the silicon slide is reviewed, together with the machined-mask applications in multilayer interconnections. T.M.

A67-28245

EFFECT OF THE SPATIAL STRUCTURE OF A LASER BEAM ON THE GENERATION OF THE SECOND HARMONIC IN ADP AND KDP CRYSTALS.

V. D. Volosov and E. V. Nilov.

(Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 715-719.)

Optics and Spectroscopy, vol. 21, Dec. 1966, p. 392-394. Translation.

Study of the effectiveness of using cylindrical optics in converting laser emission into the second harmonic in ADP and KDP crystals. It is shown that the use of cylindrical optics makes it possible to obtain maximally high laser-emission conversion coefficients at comparatively low generator powers. The highest conversion coefficient, estimated as the ratio of the second-harmonic power to the power of the entire emission passing through the crystal, is obtained on a KDP crystal and amounts to 30%. The ADP crystal is found to possess greater resistance to light loads than KDP, the KDP crystal fracturing at specific loads on the order of 190 to 200 Mw/cm^2, while the ADP crystal fractures at 500 Mw/cm^2.

A.B.K.

A67-28248

THE ABSOLUTE OSCILLATOR STRENGTH OF THE RESONANCE TRANSITION IN THE SODIUM ATOM.

M. A. Mazing and N. P. Penkin.

(Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 751, 752.)

Optics and Spectroscopy, vol. 21, Dec. 1966, p. 409, 410. 8 refs. Translation.

[For abstract see issue 09, page 1511, Accession no. A67-21919]

A67-28249

ZEEMAN EFFECT IN A NEON-HELIUM GAS LASER (λ = 6328 Å).

A. I. Povrozin and A. I. Sidorov.

(Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 754-758.)

Optics and Spectroscopy, vol. 21, Dec. 1966, p. 412, 413. 6 refs. Translation.

[For abstract see issue 09, page 1512, Accession no. A67-21920]

A67-28251

MEASUREMENT OF THE CONCENTRATION OF ELECTRONS IN A PULSED XENON DISCHARGE USING A GAS LASER.

A. G. Rozanov, N. V. Cheburkin, and N. N. Shvindt.

(Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 761, 762.)

Optics and Spectroscopy, vol. 21, Dec. 1966, p. 416, 417. Translation.

[For abstract see issue 09, page 1512, Accession no. A67-21922]

A67-28252

THE POLARIZATION OF RADIATION AND THE FREQUENCY CHARACTERISTICS OF RING LASERS WITH A TRIANGULAR RESONATOR.

S. N. Bagaev, Iu. V. Troitskii, and B. I. Troshin.

(Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 768, 769.)

Optics and Spectroscopy, vol. 21, Dec. 1966, p. 420, 421. Translation.

[For abstract see issue 09, page 1512, Accession no. A67-21923]

A67-28253

THE USE OF A MICROWAVE DISCHARGE AS THE ACTIVE MEDIUM FOR A GAS DISCHARGE LASER.

A. I. Maksimov.
(Optika i Spektroskopiia, vol. 21, Dec. 1966, p. 770, 771.)
Optics and Spectroscopy, vol. 21, Dec. 1966, p. 422, 423. 7 refs.
Translation.
[For abstract see issue 09, page 1512, Accession no. A67-21924]

A67-28261
A LASER AS A SOURCE FOR OPTICAL FOURIER TRANSFORMS.
B. K. Vainshtein and G. I. Kosourov (Akademiia Nauk SSSR, Institut Kristallografii, Moscow, USSR).
(Kristallografiia, vol. 11, Nov.-Dec. 1966, p. 921-923.)
Soviet Physics - Crystallography, vol. 11, May-June 1967, p. 778-780. Translation.

A67-28262
NEODYMIUM-DOPED CERIUM FLUORITE IN LASERS.
Iu. K. Voron'ko, A. A. Kaminskii, V. V. Osiko, and M. M. Fursikov (Akademiia Nauk SSSR, Fizicheskii Institut and Institut Kristallografii, Moscow, USSR).
(Kristallografiia, vol. 11, Nov.-Dec. 1966, p. 936-938.)
Soviet Physics - Crystallography, vol. 11, May-June 1967, p. 793-795. 11 refs. Translation.

A67-28289
DRAWING A LINE BETWEEN LASER SIGNAL POWER AND NOISE.
John Ward (International Telephone and Telegraph Corp., ITT Federal Laboratories Div., San Fernando, Calif.).
Electronics, vol. 40, May 15, 1967, p. 84-87.

Use of a nomogram to estimate the ratio between laser signal power and noise. The usefulness of laser telemetry systems is largely determined by the ratio of signal power to noise power at the output of the receiver's detector. To estimate this ratio is difficult, because it is affected by some 15 factors. However, a nomogram has been constructed that can be used to quickly predict this SNR for some common type of laser setup - a system with an amplitude-modulated helium-neon laser for a transmitter and a photomultiplier tube for a receiver. The basis of the nomogram is an equation that accounts for all important noise sources. This equation is derived from a general expression for the power-density spectrum at the output of a photodetector. P.v.T.

A67-28292
MODE-LOCKED LASER AND THE 180° PULSE.
A. G. Fox and P. W. Smith (Bell Telephone Laboratories, Inc., Crawford Hill Laboratory, Holmdel, N. J.).
Physical Review Letters, vol. 18, May 15, 1967, p. 826-828. 10 refs.

Suggestion that the pulses traveling back and forth in a mode-locked laser oscillator are 180° pulses. It is demonstrated that experimental measurements of the width of the pulse in a self-locked He-Ne laser as a function of intensity agree well with the calculated 180° pulse widths for the medium. M. M.

A67-28392
LASER MEASUREMENTS AND STANDARDS.
George Birnbaum (North American Aviation, Inc., Science Center, Thousand Oaks, Calif.).
IN: PROGRESS IN RADIO SCIENCE 1963-1966; INTERNATIONAL SCIENTIFIC RADIO UNION, GENERAL ASSEMBLY, 15TH, MUNICH, WEST GERMANY, SEPTEMBER 5-15, 1966, PROCEEDINGS. PART 1 - RADIO STANDARDS AND MEASUREMENTS, THE TROPOSPHERE, THE IONOSPHERE, THE MAGNETOSPHERE, AND NOISE OF TERRESTRIAL ORIGIN. [A67-28388 14-07]
Edited by R. W. Beatty, J. Herbstreit, G. M. Brown, and F. Horner. Berkeley, Calif., International Scientific Radio Union, 1967, p. 312-365. 63 refs.

Methods of measuring laser energy and power with emphasis on those investigations attempting to establish standards for such measurements are described. Methods of attenuating laser radiation are summarized. In practically all of this work on measuring energy, power, and attenuation, the pulsed ruby laser (6943 Å) was used as the source. Also described are methods for stabilizing laser frequency and wavelength, the determination of this stability, and the measurement of the absolute wavelength of stable lasers; this work was done with the CW He-Ne laser oscillating at 0.633, 1.15, or 3.39 μ. Optical standards of length and their use in length measurements are considered. The review covers the period from the advent of lasers in 1960 to June 1966. (Author)

A67-28466
LOW-NOISE AMPLIFIERS IN RADIO ASTRONOMY.
B. J. Robinson (Commonwealth Scientific and Industrial Research Organization, Radiophysics Laboratory, Sydney, Australia).
IN: PROGRESS IN RADIO SCIENCE 1963-1966; INTERNATIONAL SCIENTIFIC RADIO UNION, GENERAL ASSEMBLY, 15TH, MUNICH, WEST GERMANY, SEPTEMBER 5-15, 1966, PROCEEDINGS. PART 2 - RADIO ASTRONOMY, RADIO WAVES AND CIRCUITS, AND RADIO ELECTRONICS. [A67-28428 14-07]
Edited by J. W. Findlay, R. C. Hansen, and R. Burgess. Berkeley, Calif., International Scientific Radio Union, 1967, p. 2062-2089.

Discussion of the various aspects of low-noise amplifiers used in radio astronomy including traveling-wave masers, parametric amplifiers, tunnel diodes, and traveling-wave tubes. A comparison of these different types of amplifiers is presented. The parametric amplifier is the most widely used front-end in radio astronomy; the tunnel-diode (negative-resistance) amplifier is chosen at a number of observatories because of its simplicity for applications where wide bandwidth can be exploited to reduce the output fluctuation level. The performance of the low-noise traveling-wave tube is closely similar to that of the tunnel-diode amplifier. M. F.

A67-28469
PROBLEM OF A HIGH-POWER SINGLE-MODE LASER [LE PROBLEME DU LASER MONOMODE DE PUISSANCE].
J. Le Mezec (Centre National d'Etudes des Télécommunications, Issy-les-Moulineaux, Seine, France).
IN: PROGRESS IN RADIO SCIENCE 1963-1966; INTERNATIONAL SCIENTIFIC RADIO UNION, GENERAL ASSEMBLY, 15TH, MUNICH, WEST GERMANY, SEPTEMBER 5-15, 1966, PROCEEDINGS. PART 2 - RADIO ASTRONOMY, RADIO WAVES AND CIRCUITS, AND RADIO ELECTRONICS. [A67-28428 14-07]
Edited by J. W. Findlay, R. C. Hansen, and R. Burgess. Berkeley, Calif., International Scientific Radio Union, 1967, p. 2187-2205. 32 refs. In French.

Evaluation of suggested solutions to the problem of developing a high-power laser emitting monochromatic radiation. It is pointed out that the development of a laser emitting a high-power radiation at a single frequency would have applications in spectroscopy, telemetry, and telecommunications. Multiple-mirror optical resonators are discussed, and the Fabry-Pérot and Michelson structures are considered. Internal and external modulation systems are described, and the transition of an FM oscillation to the emission of a monochromatic wave is studied. M. F.

A67-28470
CONTINUOUS-WAVE SOLID-STATE LASERS.
K. Gürs (Siemens AG, Forschungslaboratorium, Munich, West Germany).
IN: PROGRESS IN RADIO SCIENCE 1963-1966; INTERNATIONAL SCIENTIFIC RADIO UNION, GENERAL ASSEMBLY, 15TH, MUNICH, WEST GERMANY, SEPTEMBER 5-15, 1966, PROCEEDINGS. PART 2 - RADIO ASTRONOMY, RADIO WAVES AND CIRCUITS, AND RADIO ELECTRONICS. [A67-28428 14-07]
Edited by J. W. Findlay, R. C. Hansen, and R. Burgess. Berkeley, Calif., International Scientific Radio Union, 1967, p. 2206-2219. 11 refs.

Discussion of CW solid-state lasers, treating three types of pump light reflectors. The principal laser crystals are considered. The construction and properties of the CW ruby laser are outlined, a laser using neodymium-doped yttrium-aluminum-garnet is described, and a comparison is made between the CW solid-state laser and the gas laser. B.B.

A67-28471
MOLECULAR-BEAM LASERS [LES LASERS MOLECULAIRES].
G. Amat (Paris, Université, Faculté des Sciences, Paris, France).
IN: PROGRESS IN RADIO SCIENCE 1963-1966; INTERNATIONAL SCIENTIFIC RADIO UNION, GENERAL ASSEMBLY, 15TH, MUNICH, WEST GERMANY, SEPTEMBER 5-15, 1966, PROCEEDINGS. PART 2 - RADIO ASTRONOMY, RADIO WAVES AND CIRCUITS, AND RADIO ELECTRONICS. [A67-28428 14-07]
Edited by J. W. Findlay, R. C. Hansen, and R. Burgess.
Berkeley, Calif., International Scientific Radio Union, 1967, p. 2221-2240. In French.

Study of the mechanisms operating in lasers which employ optical transitions of molecules in fluids. Five different kinds of molecular-beam lasers are studied: (1) lasers using a pulsed discharge and inducing an emission in the visible, the UV and the near IR; (2) chelate lasers; (3) lasers operating in the far IR; (4) lasers using an optical or chemical pumping and operating on vibration-rotation transitions; and (5) lasers using a discharge and operating on vibration-rotation transitions. M.F.

A67-28494
VISIBLE SIDE-LIGHT EMISSION PROPERTIES OF A CO_2-N_2-He PLASMA INDUCED BY THE CO_2 LASER RADIATION FIELD.
R. Anthony Crane and Armand L. Waksberg (RCA Victor Co., Ltd., Research Laboratories, Montreal, Canada).
Applied Physics Letters, vol. 10, May 1, 1967, p. 237-239.
Research supported by the Canadian Directorate of Industrial Research.

Study of the effect of laser action in CO_2 laser plasmas on the spontaneous light emission in the visible spectral region. It has been observed that the discharge current and the overall visible side-light intensity from the plasma decrease by sizable amounts when the laser action is switched on. It was found, however, that, at the same time, several spectral lines increase in intensity, indicating that in some of these levels direct collisional processes are involved. An interpretation in terms of collisional effects between the highly excited molecules and those molecules which are in the laser cycle is suggested. The phase-lock technique was used to study the change in the plasma current when the laser beam was switched on and off. P.v.T.

A67-28498
COMPETITIVE AND CASCADE COUPLING BETWEEN TRANSITIONS IN THE CW WATER VAPOR LASER.
M. A. Pollack, T. J. Bridges, and W. J. Tomlinson (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
Applied Physics Letters, vol. 10, May 1, 1967, p. 253-256. 8 refs.

CW operation on five additional lines between 47 and 79 μ has been observed in the water vapor laser. Competitive and cascade coupling have been shown to exist between the nine presently known CW lines. These interconnections are the first reported for the water vapor laser, and may assist in the identification of the unknown laser species and energy levels. Lamb dips have been observed on three additional lines, and pressure-broadened linewidths have been derived from measurements of the dips. (Author)

A67-28528 #
MICROINHOMOGENEITIES OF THE IMPURITY DISTRIBUTION IN HEAVILY DOPED GALLIUM ARSENIDE [MIKRONEODNORODNOSTI RASPREDELENIIA PRIMESI V SIL'NO LEGIROVANNOM ARSENIDE GALLIIA].
G. P. Proshko and V. I. Shveikin.
Fizika i Tekhnika Poluprovodnikov, vol. 1, Apr. 1967, p. 514-518. 6 refs. In Russian.

Application of gas-laser radiation to the measurement of the light transmittance of heavily doped GaAs in the region of absorption by free carriers. It is shown that microinhomogeneities appear only in samples of a width comparable to the length of the cylindrical portion of the laser beam. It is found that the relative nonuniformity of the impurity distribution is inversely proportional to the concentration. V.P.

A67-28534 #
MECHANISM OF GENERATION OF LASER EMISSION IN CdS_x-$CdSe_{1-x}$ CRYSTALS IN THE PRESENCE OF TWO-PHOTON EXCITATION [O MEKHANIZME GENERATSII LAZERNOGO IZLUCHENIIA V KRISTALLAKH CdS_x-$CdSe_{1-x}$ PRI DVUKHFOTONNOM VOZBUZHDENII].
M. S. Brodin, S. V. Zakrevskii, V. S. Mashkevich, and V. Ia. Reznichenko (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki, Kiev, Ukrainian SSR).
(Soveshchanie po Teorii Poluprovodnikov, 7th, Tartu, Estonian SSR, June 1966.)
Fizika i Tekhnika Poluprovodnikov, vol. 1, Apr. 1967, p. 595-597 11 refs. In Russian.

Experimental study of the generation of laser emission in CdS_x-$CdSe_{1-x}$ crystals in the presence of two-photon excitation at various temperatures. Upon comparing the data thus obtained with certain theoretical findings, it is concluded that in the temperature range from 4 to 20°K generation occurs on bound excitons, while in the temperature range from 77 to 105°K it occurs on free excitons with the participation of a longitudinal optical phonon. A.B.K.

A67-28539
HEATING AND DECAY OF PLASMA PRODUCED BY A GIANT LASER PULSE FOCUSED ON A SOLID TARGET.
N. G. Basov, V. A. Boiko, V. A. Dement'ev, O. N. Krokhin, and G. V. Sklizkov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, Oct. 1966, p. 989-1000.)
Soviet Physics - JETP, vol. 24, Apr. 1967, p. 659-666. 17 refs. Translation.

A67-28542
THE EFFECT OF COLLISIONS ON SPECTRAL CHARACTERISTICS OF GAS LASERS.
S. G. Rautian (Akademiia Nauk SSSR, Sibirskoe Otdelenie, Institut Fiziki Poluprovodnikov, Novosibirsk, USSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, Oct. 1966, p. 1176-1188.)
Soviet Physics - JETP, vol. 24, Apr. 1967, p. 788-796. 17 refs. Translation.

A67-28559
SOLID-STATE LASERS FOR CONTINUOUS AND QUASI-CONTINUOUS OPERATION.
Dieter Röss (Siemens AG, Zentral-Laboratorium, Munich, West Germany).
Siemens Review, vol. 34, May 1967, p. 158-167. 11 refs.

Discussion of solid state lasers and of some of their applications. Solid-state lasers for continuous and quasi-continuous operation and pulsed ruby lasers for quasi-continuous operation are described. YAG:Nd^{3+} lasers for continuous operation are analyzed, and micromachining with 1-in. and 3-in. pulsed lasers is evaluated. B.B.

A67-28602 #
OPTICAL RECONSTRUCTION FROM SAMPLED HOLOGRAMS MADE WITH SOUND WAVES.
A. F. Metherell, J. J. Dreher, L. Larmore (Douglas Aircraft Co., Inc., Advanced Research Laboratories, Huntington Beach, Calif.), and H. M. A. El-Sum.
Physics Letters, vol. 24A, May 8, 1967, p. 547, 548.
Research sponsored by the Douglas Aircraft Co.

Description of experiments in which a reconstructed image was formed from a sampled hologram made using sound waves at a frequency of 21 kc. Light from a He-Ne laser was used in the reconstruction. The hologram is called a sonoptigram because it was made using sound instead of light. M.F.

A67-28603 #
OBSERVATION OF COUPLED OSCILLATIONS BETWEEN THE MODES OF A He-Ne LASER [BEOBACHTUNG VON KOPPEL-SCHWINGUNGEN ZWISCHEN DEN MODEN EINES He-Ne LASERS].
D. Schubert (Jena, Universität, Physikalisches Institut, Jena, East Germany).
Physics Letters, vol. 24A, May 8, 1967, p. 558, 559. In German.

Investigation of energy-exchange oscillations between three TEM_{00q}-type modes of a He-Ne laser operating at $\lambda = 6328$ Å. The power spectrum of the laser and the difference frequency spectrum, obtained with a dual trace oscilloscope, are examined. V.P.

A67-28608 #
SOME LASER SPACE APPLICATIONS [QUELQUES APPLICATIONS SPATIALES DES LASERS].
Robert Bivas.
Sciences et Industries Spatiales, vol. 3, no. 3-4, 1967, p. 49-55. In French.

Use of the highly special characteristics of lasers for space applications, particularly with reference to satellite tracking, using a principle analogous to that of radar. Measurements of the distance from station to satellite enable a quick calculation to be made from a single station of the parameters of the orbits of satellites equipped with appropriate reflectors. The same principle can be applied to the telemetry of machines in flight and to measurement of the distance, the form, and the motions of the moon. Various sorts of atmospheric studies can be made by using lasers, and current or anticipated tests are briefly described. F.R.L.

A67-28713
MEASUREMENT OF THE LASER TRANSITION CROSS SECTION FOR Nd^{+3} IN YTTRIUM ALUMINUM GARNET.
J. K. Neeland and V. Evtuhov (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.).
Physical Review, 2nd Series, vol. 156, Apr. 10, 1967, p. 244-246. 6 refs.
Contract No. AF 33(657)-11650.

This paper reports measurements of the room-temperature laser transition cross section of Nd^{+3} in yttrium aluminum garnet at 1.06 μ. One method used is based on the measured upper-state lifetime and a determination of the fluorescence branching ratio for this state. The value thus determined is 3.5×10^{-19} cm^2. The second method involves measurement of the ratio of fluorescent intensities from the upper laser level to the ground state and to the lower laser level, and measurement of the cross section in absorption of the transition which involves the ground state. The second method yields a value of 2.7×10^{-19} cm^2. The difference represents the contribution of fluorescence to high-lying levels (not included in the determination of branching ratio) and nonradiative transitions. The probable experimental accuracy in both methods is ±15%.
(Author)

A67-28715
MODE INTERACTION IN A ZEEMAN LASER.
W. Culshaw and J. Kannelaud (Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Research Laboratories, Palo Alto, Calif.).
Physical Review, 2nd Series, vol. 156, Apr. 10, 1967, p. 308-319. 19 refs.
Research supported by the Lockheed Independent Research Funds.

The interaction between modes of a short He-Xe laser using the $J = 1 \rightarrow 0$ transition at 2.65 μ is investigated in an axial magnetic field. In zero field an elliptically polarized output usually predominates, with orientation and eccentricity changing with conditions and reflector characteristics. Neutral coupling occurs here; consequently, the system is sensitive to perturbations, in agreement with the observed erratic behavior. Small axial magnetic fields produce circular polarizations, quenching, and hysteresis effects between the two Zeeman oscillations arising from the frequency splitting of a single axial mode. A strong interaction, including sharp crossover regions in the intensities and quenching phenomena, is observed between two axial modes oscillating on well-resolved oppositely circularly polarized Zeeman components. The phenomena are studied as a function of cavity tuning, laser intensity, pressure, and magnetic field. No hysteresis was observed in the interaction between axial modes. The axial-mode intensities are equal for all positions of cavity tuning when the Zeeman separation equals the axial-mode interval. For small deviations of magnetic field from this value, however, crossover and quenching effects appear, and this allows a precise determination of the g value of the upper state. These effects are discussed on the basis of Lamb's theory and equations deduced for the interaction. The Doppler parameter Ku is about 100 Mc for xenon, which is comparable with the natural linewidths, and requires a more exact discussion of the third-order atomic polarization terms. The results derived show some qualitative agreement with observations, particularly on the axial-mode interaction, which is discussed in detail. (Author)

A67-28716
QUANTUM THEORY OF A GAS LASER.
Charles R. Willis (Boston University, Boston, Mass.).
Physical Review, 2nd Series, vol. 156, Apr. 10, 1967, p. 320-330. 14 refs.
USAF-sponsored research.

Derivation of the equation of motion for the quantum-mechanical radiation-density matrix of a gas laser to lowest order in the dimensionless coupling constant. The derivation is fully quantum mechanical, and it is possible to calculate the coherence properties from the radiation density matrix. The model used consists of N two-level systems interacting with radiation in a cavity in the presence of dissipation, pumping, and collisions. The method used is a generalization of the Bogoliubov derivation of the kinetic equation for a small parameter. The derivation holds for any physically realizable pump power and near threshold reduces to Lamb's near-threshold theory. With the equation of motion for the radiation-density matrix, solutions are obtained both for the case when the average field is nonzero and for the case when it is zero. The steady-state electromagnetic density is the same in both cases, except for a small spontaneous-emission term. It is shown that the reason why gas lasers do not satisfy rate equations is the existence of zeroth-order correlations between the internal atomic variables and atomic center-of-mass variables. M.M.

A67-28722
BILINEAR REFLECTION OF A DOUBLE-FREQUENCY LASER BEAM FROM A SUPERCONDUCTOR.
K. K. Gupta and Sudhanshu S. Jha (Tata Institute of Fundamental Research, Bombay, India).
Physical Review, 2nd Series, vol. 156, Apr. 10, 1967, p. 444-451. 18 refs.

The bilinear current density induced in a superconducting metal by a laser beam with frequencies ω_1 and ω_2 has been calculated. The calculation is done within the framework of the BCS theory of superconductivity at temperature $T = 0^{\circ}K$. It is shown that in the superconducting state of the metal the component of the induced current density, varying with the difference frequency $\Omega = \omega_1 - \omega_2$ and the wave vector $\vec{Q} = \vec{q}_1 - \vec{q}_2$, where $\vec{q}_1$ and $\vec{q}_2$ are the wave vectors of the fundamental fields in the metal, differs considerably from the corresponding component in the normal state of the metal when $\hbar\Omega$ is of the order of the energy gap 2Δ. In the paper only that special case is considered where the wave vector Q is such that $\hbar Q v_f \ll 2\Delta$, v_f being the Fermi velocity of the electrons. If the collision frequency Ω_c^S of the electrons in the superconducting state is small compared to Ω, there is a sharp peak at $\hbar\Omega = 2\Delta$ in the energy flux

of the light wave of frequency Ω reflected from the surface of the superconductor. For $\hbar\Omega \gg 2\Delta$, the reflectivities are the same for both the normal and the superconducting states of the metal.

(Author)

A67-28759 #

ADJUSTMENT AND STABILIZATION OF THE WAVELENGTH OF RUBY LASER RADIATION [PRO PERESTROIUVANNIA I STABILIZATSIIU DOVZHINI KHVILI VIPROMINIUVANNIA RUBINOVOGO OPTICHNOGO KVANTOVOGO GENERATORA].

M. V. Danileiko, V. I. Kravchenko, S. G. Odulov, O. M. Pogorilii, and M. S. Soskin (Akademiia Nauk Ukrains'koi RSR, Institut Fiziki, Kiev, Ukrainian SSR).

Ukrains'kii Fizichnii Zhurnal, vol. 12, Apr. 1967, p. 627-630. 6 refs. In Ukrainian.

Experimental study of the performance of a ruby laser with a Fabry-Perot interferometer-selector inserted in its resonator for wavelength and thermal stability control. Optimal parameters are determined for the selector to achieve smooth adjustment and stabilization of the working wavelength in the R_1 spectral line. The dependence of the working wavelength on the angle of rotation of the selector and on the temperature of the ruby crystal is given. V.Z.

A67-28799 *

LASERS VS MICROWAVES FOR DEEP-SPACE COMMUNICATIONS.

Edward C. Park and Lyle S. Stokes (Hughes Aircraft Co., Culver City, Calif.).

Microwaves, vol. 6, May 1967, p. 78-90. 20 refs.

Contract No. NAS 12-81.

Comparison of microwaves and laser links for spacecraft-to-earth communications, and description of a hybrid system combining the best features of lasers and microwaves. Significant restrictions on communication-system performance are due to external noise sources and atmospheric effects, which identify certain favorable regions of the spectrum, and to engineering and technological limitations on aperture gain, which determine the achievable levels of performance within these favorable regions. Distortions of the incident wavefront caused by atmospheric turbulence limit the effective dimensions. Fabrication tolerances set gain limits to both received and transmitted apertures. Gain is finally limited at the high-frequency end of the spectrum by the need for a beamwidth comparable to expected pointing errors. P.v.T.

A67-28812

SAGNAC EFFECT.

E. J. Post (USAF, Office of Aerospace Research, Cambridge Research Laboratories, Bedford, Mass.).

Reviews of Modern Physics, vol. 39, Apr. 1967, p. 475-493. 45 refs.

Study of the literature and the older kinematical theory of the Sagnac effect, in which a revived interest has recently resulted, due to the development of the self-oscillating laser version of the original Sagnac interferometer. This geometrical optical theory is complemented and compared with more recent work based on a physical optical analysis, using a complete electromagnetic description of the phenomenon. B.B.

A67-28818

LASER TECHNOLOGY.

Alex Stein (Control Data Corp., TRG Div., Menlo Park, Calif.).

Signal, vol. 21, May 1967, p. 76, 78.

Consideration of selected topics concerning laser technology. Q-switched laser beams, a feature of which is their extremely short duration and resulting high peak power, can be used for active range-finding, target illumination, tracking, and acquisition of distant targets. Due to their high degree of spatial coherence even when pulsed, lasers can be used for extremely fine drilling, cutting, and welding processes. Certain experiments are feasible in biological and biomedical studies. Of all laser types, gas lasers have served the widest range of applications. Some future possibilities are discussed. F.R.L.

A67-28854 #

DIVERGENCE OF GAS-LASER RADIATION GENERATED BY TEM_{nm} MODES [O RASKHODIMOSTI IZLUCHENIIA GAZOVYKH LAZEROV PRI GENERATSII NA MODAKH TIPA TEM_{nm}].

F. A. Abramskii.

Optika i Spektroskopiia, vol. 22, Apr. 1967, p. 611-613. 6 refs. In Russian.

Analysis of the function of a symmetrical gas-laser resonator in an attempt to determine the angle of divergence of the laser beams produced by various TEM modes. It is found that the angle of divergence of a light beam produced by the TEM_{nm} mode of a gas laser operating in a single-mode regime is a monotonic function of the mode order of magnitude and increases with increasing absolute values of the maximum roots of the Hermitian polynomials $H_m(x)$. V.Z.

A67-28856 #

INTERACTION BETWEEN TRAVELING WAVES IN AN ANNULAR GAS LASER [O VZAIMODEISTVII BEGUSHCHIKH VOLN V GAZOVOM KOL'TSEVOM LAZERE].

V. N. Lisitsyn and B. I. Troshin.

Optika i Spektroskopiia, vol. 22, Apr. 1967, p. 666-668. In Russian.

Brief account of an experimental study of the interaction between oppositely moving traveling waves in a He-Ne laser with a ring-type resonator. Changes in the output radiation oscillograms of the experimental laser, produced by changes in the resonator length, are discussed. V.Z.

A67-28857 #

EFFECT OF THE INERT-SHIELD TEMPERATURE ON LASER PERFORMANCE [VLIIANIE TEMPERATURY PASSIVNOGO ZATVORA NA RABOTU LAZERA].

M. P. Lisitsa and N. R. Kulish.

Optika i Spektroskopiia, vol. 22, Apr. 1967, p. 671, 672. In Russian.

Note on the performance of lasers using organic-dye and semiconductor-glass shields for Q-factor modulation. The effect of the temperature of a semiconductor glass shield on the absorption coefficient, output energy, pulse energy and duration, and peak power of a ruby laser is investigated. A sharp drop of output energy at higher shield temperatures is noted. V.Z.

A67-28970 #

PROGRESS IN THE FIELD OF GAS LASERS [OSIĄGNIĘCIA W DZIEDZINIE LASERÓW GAZOWYCH].

Wieslaw Woliński (Warszawa, Politechnika, Katedra Przyrządów Elektronowych, Warsaw, Poland).

(Ogólnopolska Konferencja Radiospektroskopii i Elektroniki Kwantowej, 2nd, Poznan, Poland, Apr. 25-28, 1966, Paper.)

Postępy Fizyki, vol. 18, no. 2, 1967, p. 151-167. 35 refs. In Polish.

Review of some recent advances in gas laser technology, with particular reference to single-frequency, far-infrared, and high-power lasers. Some solutions of problems arising in the design and manufacture of short single-frequency lasers are examined, together with methods of obtaining single frequency from long lasers. The media used to obtain laser action in the far infrared are noted, and the design of the H_2O-vapor laser is studied together with its applications. Some technological problems of the pulsed laser and the CW ion laser are examined. V.P.

A67-28971 #

EXPERIMENTAL METHOD FOR DETERMINING OPTIMUM COUPLING IN A GAS LASER [DOŚWIADCZALNY SPOSÓB WYZNACZENIA OPTYMALNEGO SPRZĘŻENIA W LASERZE GAZOWYM].

M. Kutik (VÚVET, Prague, Czechoslovakia).

(Ogólnopolska Konferencja Radiospektroskopii i Elektroniki Kwantowej, 2nd, Poznań, Poland, Apr. 25-28, 1966, Paper.)

Postępy Fizyki, vol. 18, no. 2, 1967, p. 169-173. 5 refs. In Polish. (Translation).

Development of a method for determining the optimum energy coupling of a multimode gas laser. The condition for optimum coupling is formulated analytically, and a nonlinear relation

between the energy of the electromagnetic field and resonator losses is established experimentally. With the aid of these results, the value of the optimum transparency is determined by a graph-analytical method, together with the value of optimum output power. It is shown how the obtained relation between the field intensity and resonator losses can be used to determine the individual resonator-element losses (due to Brewster windows, mirrors, etc.) as well as the effect of their variation on laser output power. V. P.

A67-28972 #
GAS LASERS [LASERY GAZOWE].
František Petrů (Czechoslowacka Akademia Nauk, Instytut Aparatury Naukowej, Brno, Czechoslovakia).
(Ogólnopolska Konferencja Radiospektroskopii i Elektroniki Kwantowej, 2nd, Poznań, Poland, Apr. 25-28, 1966, Paper.)
Postępy Fizyki, vol. 18, no. 2, 1967, p. 175-183. 16 refs. In Polish.

Discussion of results obtained with two He-Ne lasers employing an 800-mm and a 1265-mm optical resonator, respectively, and operating at $\lambda = 0.63\mu$, $\lambda = 1.15\mu$, and $\lambda = 3.39\mu$. Specifically examined are problems associated with obtaining maximum output power and the application of lasers as light sources in Raman spectroscopy. Some interferometric measurements are included. V. P.

A67-28973 #
USE OF LASERS AS RETINAL PHOTOCOAGULATORS [ZASTOSOWANIE LASERÓW JAKO FOTOKOAGULATORÓW SIATKÓWKOWYCH].
Jan Blabla (Československá Akademie Věd, Ústav Radiotechniky a Elektroniky, Prague, Czechoslovakia).
(Ogólnopolska Konferencja Radiospektroskopii i Elektroniki Kwantowej, 2nd, Poznań, Poland, Apr. 25-28, 1966, Paper.)
Postępy Fizyki, vol. 18, no. 2, 1967, p. 185-193. 5 refs. In Polish.

Investigation of the effect of laser light on the human eye, with particular reference to the potentialities of the solid-state laser as a retinal coagulation source. The experimental investigation of the laser parameters and the parameters of the coagulated object is described, the results of which are useful in diagnostics and the operation required. The optimum conditions for the experiment are established on the basis of geometrical optics. V. P.

A67-28974 #
SURVEY OF CURRENT AND FUTURE LASER APPLICATIONS [PRZEGLĄD AKTUALNYCH I PERSPEKTYWICZNYCH ZASTOSOWAŃ LASERA].
Herman Klejman (Komitet Nauki i Techniki, Warsaw, Poland).
(Ogólnopolska Konferencja Radiospektroskopii i Elektroniki Kwantowej, 2nd, Poznań, Poland, Apr. 25-28, 1966, Paper.)
Postępy Fizyki, vol. 18, no. 2, 1967, p. 195-214. 26 refs. In Polish.

General review of laser applications, with particular reference to telemetry, radar, telecommunications, and navigation. Prospective laser applications, some of which are in the experimental stage, are also examined. V. P.

A67-28975 #
REVIEW OF ATOMIC AND MOLECULAR FREQUENCY STANDARDS [PRZEGLĄD ATOMOWYCH I MOLEKULARNYCH WZORÓW CZĘSTOŚCI].
Viktor Trhal.
(Ogólnopolska Konferencja Radiospektroskopii i Elektroniki Kwantowej, 2nd, Poznań, Poland, Apr. 25-28, 1966, Paper.)
Postępy Fizyki, vol. 18, no. 2, 1967, p. 215-222. 10 refs. In Polish.

Analysis of the characteristics of atomic and molecular frequency standards. The advantages and drawbacks of quantum frequency standards are compared on the example of the ammonia and hydrogen masers and cesium, thallium, and rubidium gas frequency standards (the rubidium device having optical pumping). V. P.

A67-28985
STIMULATED INVERSE RAMAN EFFECT [EFFET RAMAN INVERSE STIMULE].
S. Dumartin, B. Oksengorn, and B. Vodar (Centre National de la Recherche Scientifique, Laboratoire des Hautes Pressions, Bellevue, Seine-et-Oise, France).
(Société Française de Physique, Colloque sur les Phonons et Hypersons, Université de Grenoble, Grenoble, France, Mar. 31-Apr. 2, 1966, Communication.)
Journal de Physique, vol. 28, no. 2, supplément, Feb. 1967, p. C1-9 to C1-102. 16 refs. In French.

Observation of a new type of Raman absorption on the Stokes side, the "stimulated inverse Raman effect." This effect was observed by (1) using an intense light beam given by a Q-switched laser associated with a continuum emitted by a compressed gas in which the laser beam is focused and (2) adjusting the beam energy close to the threshold of the stimulated Raman emission. This new process can be explained using the hypothesis of a stimulated emission of optical phonons, which are absorbed very strongly and give an inversion of population for the vibrational levels of the molecules; therefore, the Stokes photons may be strongly absorbed from the excited level. M.F.

A67-28987
GENERATION OF ELASTIC WAVES BY LASER RADIATION PRESSURE [GENERATION D'ONDES ELASTIQUES PAR PRESSION DE RADIATION LASER].
M. Bruma (Centre National de la Recherche Scientifique, Laboratoires, Bellevue, Seine-et-Oise, France).
(Société Française de Physique, Colloque sur les Phonons et Hypersons, Université de Grenoble, Grenoble, France, Mar. 31-Apr. 2, 1966, Communication.)
Journal de Physique, vol. 28, no. 2, supplément, Feb. 1967, p. C1-129 to C1-134. In French.

Evidence is presented of elastic waves induced in metals when irradiated with pulsed laser beams. The experimental technique is based on the acoustic equivalent of the Fabry-Pérot resonator: a metal rod with plane, parallel, polished end faces. A piezoelectric transducer is attached to one face, the opposite face being irradiated by the laser beam. Variations of rod length, diameter, reflectivity of the irradiated face, also of the energy, time duration, power and cross section of the incident laser pulse are correlated with the response of the piezoelectric transducer on the screen of a double beam oscillograph. Results are presented for metal rods of a length up to 300 cm and diameter up to 2.5 cm, irradiated with conventional and Q-switched ruby laser pulses of 1 to 10 joules energy, focused and unfocused. It is shown that radiation pressure, exclusive of thermal effects, is responsible for elastic wave generation in metals irradiated by a pulsed laser beam. (Author)

A67-29074 #
VAPORIZATION OF A SUBSTANCE UNDER THE ACTION OF LASER RADIATION [ISPARENIE VESHCHESTVA POD DEISTVIEM IZLUCHENIIA LAZERA].
Iu. V. Afanas'ev and O. N. Krokhin (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, no. 4, 1967, p. 966-975. 22 refs. In Russian.

Theoretical consideration of the vaporization of substances under the action of laser radiations from 10^6 to 10^9 watts/cm^2 in terms of the gas-dynamic equations. The boundary conditions are formulated and exact analytical solutions are derived for vaporization and heating processes occurring in radiation-transmitting substances at the lower and higher radiation-density levels. Expressions are given for the gas-dynamic characteristics as functions of the radiation density and the parameters of the condensed substance. V. Z.

A67-29078 #
RESONANCE PHENOMENA IN THE FIELD OF AN INTENSE LASER BEAM [REZONANSNYE EFFEKTY V POLE INTENSIVNOGO LAZERNOGO LUCHA].

V. P. Oleinik (Akademiia Nauk Ukrainskoi SSR, Institut Poluprovodnikov, Kiev, Ukrainian SSR).
Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, no. 4, 1967, p. 1049-1067. 18 refs. In Russian.

Discussion of electron-electron scattering involving virtual photon exchange (Moller scattering) in the presence of the field of a monochromatic laser beam. The effective Moller scattering cross section is found to contain resonances due to the discreteness of the energy spectrum of the electron/plane electromagnetic wave system. The value of the Moller scattering is estimated with the aid of the total photon Green's function. Conditions are defined under which the effective potential of a two-electron interaction becomes the electron attraction potential in the field of a plane electromagnetic wave. V.Z.

A67-29080
STRAPDOWN INERTIAL NAVIGATION SYSTEMS.
Bernard Schwartz.
Sperry Engineering Review, vol. 20, no. 1, 1967, p. 9-16.

Discussion of rate-measuring strapdown inertial navigation systems, with emphasis on a Sperry strapdown inertial measurement unit. The heart of this unit consists of three SYG-1440 high-rate, gas-bearing gyros. Another type of unit is described, in which a three-axis ring laser replaces the gyroscope as the angular rate-sensing instrument. A high-speed DDA computer is used in this system to update attitude data at a rate of 31,250 bits/sec. R. B. S.

A67-29091
THE INFLUENCE OF HIGHER ORDER CONTRIBUTIONS TO THE CORRELATION FUNCTION OF THE INTENSITY FLUCTUATION IN A LASER NEAR THRESHOLD.
H. Risken and H. D. Vollmer (Stuttgart, Technische Hochschule, I. Institut für theoretische Physik, Stuttgart, West Germany).
Zeitschrift für Physik, vol. 201, no. 3, 1967, p. 323-330. 10 refs.

Investigation of the influence of higher-order contributions to the correlation function of the intensity fluctuation in a laser near threshold, using the solution of the Fokker-Planck equation. It is found that at a point slightly above threshold higher contributions have to be taken into account - i.e., the noise spectrum of the intensity consists of several Lorentzian lines. It is shown that an effective Lorentzian line, the width of which is 25% larger than the width of the first Lorentzian line can be introduced with good accuracy at a point slightly above threshold. R.B.S.

A67-29125 #
ULTRASONIC DEVICE FOR THE MEASUREMENT OF LASER RADIATION POWER [UL'TRAZVUKOVOI PRIBOR DLIA IZMERENIIA MOSHCHNOSTI IZLUCHENIIA OPTICHESKOGO KVANTOVOGO GENERATORA].
A. N. Bondarenko, G. V. Krivoshchekov, and S. I. Marennikov (Akademiia Nauk SSSR, Sibirskoe Otdelenie, Institut Fiziki Poluprovodnikov, Novosibirsk, USSR).
Pribory i Tekhnika Eksperimenta, Mar.-Apr. 1967, p. 226, 227. In Russian.

Description of a method and equipment used to measure the power output of pulse lasers in terms of the intensity of ultrasonic vibrations induced in piezocrystals by the radiation. The results of some of the measurements which were taken are discussed in terms of the amplitude of the crystal oscillation in relation to the power output of the laser. T.M.

A67-29139 #
POSSIBILITY OF A MASER EFFECT IN INTERSTELLAR-HYDROGEN CLOUDS IN THE GALACTIC CORONA [VOZMOZHNOST' MAZERNOGO EFFEKTA NA OBLAKAKH MEZHZVEZDNOGO VODORODA V GALAKTICHESKOI KORONE].
I. S. Shklovskii (Moskovskii Gosudarstvennyi Universitet, Astronomicheskii Institut, Moscow, USSR).
Astronomicheskii Zhurnal, vol. 44, no. 2, 1967, p. 304-308. 5 refs. In Russian.

Discussion of observations of the existence of interstellar-hydrogen clouds at moderate and high galactic latitudes with radial velocities in excess of 70 km/sec. A hypothesis is proposed according to which the radiation at the 21-cm wavelength in the galactic corona may be caused by a maser effect. It is pointed out that pumping occurs by the red wing of the L_α line as the clouds move toward a source of UV quanta. It is shown that the population inversion of hyperfine-structure hydrogen-atom levels may reach as much as 10%, in which case the maser effect should be appreciable. Most of the difficulties encountered in the theory of these clouds vanish, because in the new interpretation the gaseous mass in the coronal clouds decreases by a factor of several hundred. Specifically, the negative radial velocities of coronal clouds can be explained in terms of the operational conditions of the natural cosmic maser. V.P.

A67-29163
WATCHING THE INVISIBLE ENEMY.
Electronics, vol. 40, May 29, 1967, p. 100-103.

Discussion of trends in the production of radar, IR, and laser sensors for airborne reconnaissance. An IR detector array composed of long strings of mesa-type detectors with diffused junctions made in single chips of indium-antimonide semiconductor is examined, along with the IR system AN/AAS-18, used in the RF-4C Phantom. Operational characteristics of an airborne line-scan laser system that illuminates the terrain with a sharp pinpoint of light are presented. The light reflected from the terrain builds a photograph on standard film by a video sequential-type scanning process. The camera uses a continuous wave that is coherent, monochromatic, and unidirectional. The system operates well at high speeds. Also described is the AN/APQ-102A sidelooking radar mapping set, used in the Phantom. The ideal location for data presentation is discussed. R.B.S.

A67-29173
EFFECTS OF MAGNETIC FIELD ON PULSE AND CW OPERATION OF THE LARGE BORE IONIZED GAS LASER.
S. A. Ahmed, T. J. Faith, and G. W. Hoffman (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., David Sarnoff Research Center, Princeton, N.J.).
IEEE, Proceedings, vol. 55, May 1967, p. 691, 692.
Contract No. DA-28-043-AMC-01890(E).

Experimental investigation of CW and pulse measurements which distinguish between ion-drift gas-pumping effects and other factors affecting laser output as a function of the confining magnetic field for large-diameter ionized gas lasers. It was found that with pulse lengths too short for pumping to occur, laser operation optimizes at 400 gauss, whereas in CW operation the optimum magnetic field may be > 2600 gauss at low pressures. M.M.

A67-29178
SILICON AND CHLORINE LASER OSCILLATIONS IN $SiCl_4$.
W. C. Carr and R. W. Grow (Utah, University, Microwave Device and Physical Electronics Laboratory, Dept. of Electrical Engineering, Salt Lake City, Utah).
IEEE, Proceedings, vol. 55, May 1967, p. 726. 5 refs.
NSF Grant No. GK-29.

Discussion of observations of lasing on several Si II and Cl II lines in a pulsed gaseous discharge in $SiCl_4$ vapor. Laser output as a function of current indicates that one Si II line lases in the afterglow of the discharge. Possible mechanisms for achieving the population inversion are noted. M.M.

A67-29236 #
FEASIBILITY OF MODULATING THE EMISSION OF A SEMICONDUCTOR LASER BY CURRENT-CARRIER HEATING [VOZMOZHNOST' MODULIATSII IZLUCHENIIA POLUPROVODNIKOVOGO KVANTOVOGO GENERATORA PUTEM RAZOGREVA NOSITELEI TOKA].
N. G. Basov, Iu. M. Popov, and A. V. Uspenskii (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Akademiia Nauk SSSR, Doklady, vol. 173, Apr. 11, 1967, p. 1036-1039. 6 refs. In Russian.

Analysis showing that the output power of a semiconductor laser can be varied by decreasing the inverse population through heating of an electron-hole gas, for example, by intense optical radiation. Contrary to other methods, this technique does not involve a change in the number of active electron-hole pairs, but only a change in their effective temperature. V.P.

A67-29302
LARGE-SCREEN DISPLAYS.
Paul G. Thomas.
Space/Aeronautics, vol. 47, May 1967, p. 82-91. 11 refs.

Recommendation of large-screen displays, big enough to portray large areas viewed by space and ground sensors, and to stimulate group interaction. Problems are posed, from the angle of mechanization, by handwidth limits, eratic duty cycles, data mixing and maintenance. All the large screen displays discussed share a variety of accouterments, that perpetuate operating costs. In addition to the space required to implement these techniques, projection-throw distances demand costly facility space. All these cost items, whether they be consumable, low-MBTF components, or the need to interface many technologies, would disappear in an all-solid-state system, which is now starting to show promise for the large-screen role. All the applications are still waiting for the proper match of techniques. P.v.T.

A67-29345 #
A SOLID STATE 8 MM TWO-LEVEL QUANTUM OSCILLATOR AND AMPLIFIER WITH INCREASED INVERSION REPETITION FREQUENCY.
Ia. L. Shamfarov (Akademiia Nauk Ukrainskoi SSR, Institut Radiofiziki i Elektroniki, Kharkov, Ukrainian SSR).
(Radiotekhnika i Elektronika, vol. 11, Nov. 1966, p. 2044-2052.)
Radio Engineering and Electronic Physics, vol. 11, Nov. 1966, p. 1796-1803. 7 refs. Translation.

A67-29360
LASER WITH NEODYMIUM-ACTIVATED α-GAGARINITE.
Kh. S. Bagdasarov, A. A. Kaminskii, Ia. E. Lapsker, and B. P. Sobolev (Akademiia Nauk SSSR, Institut Kristallografii, Moscow, USSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, Apr. 1, 1967, p. 220-223.)
JETP Letters, vol. 5, Apr. 1, 1967, p. 175-178. 8 refs. Translation.

Preliminary results of investigations of a new laser based on an α-gagarinite crystal activated with Nd^{3+} and operating at 300°K. The α-gagarinite crystals obtained by the authors led to the discovery of a new series of active laser media, namely crystals of ternary fluoride systems, which are characterized by a great variety of optical centers (OCs). A strong dependence of the spectra of α-gagarinite on the concentration of the activator favors the assumption that considerable rearrangements of the OCs and changes in the lasing properties are possible in this system. This feature may make lasers with controlled spectral characteristics feasible. M.F.

A67-29376 #
NEW SYSTEMS OF TRAJECTOGRAPHY [NOUVEAUX DISPOSITIFS DE TRAJECTOGRAPHIE].
Roland Moreau (ONERA, Châtillon-sous-Bagneux, Seine).
(Société Française des Electroniciens et Radioélectriciens, Réunion, Paris, France, Nov. 21, 1966, Communication.)
ONERA, TP no. 466, 1967. 39 p. In French.

Consideration of two systems of trajectography, one based on atomic clocks and the other on the use of lasers. Atomic clocks open the way to systems of trajectography which are theoretically very simple. The principle investigated includes the possibility of using, on the vehicle or on the ground, oscillators which remain synchronous for the total duration of the experiment. Q-switched ruby lasers, related to passive transponders, make it possible to construct high-precision rangefinders which may be used to determine the trajectories of various vehicles. Experimental stations based on these two principles are described. F.R.L.

A67-29388
NORMAL MODES OF A FERROMAGNETIC LASER WITH ONE BREWSTER FACE.
C. G. B. Garrett (Bell Telephone Laboratories, Inc., Optical Research Dept., Murray Hill, N.Y.).
IEEE Journal of Quantum Electronics, vol. QE-3, Apr. 1967, p. 139-142. 7 refs.

Normal modes are determined for a solid-state laser constructed with one Brewster angle face that incorporates a gyrotropic host crystal. It is shown that, depending on the amount of Faraday rotation down the length of the crystal, the modes may be either linearly or elliptically polarized. Values for reflection loss and resonant frequency are determined. These calculations may be used to determine optimum conditions for modulation of amplitude, polarization aspect, and frequency of the output of a YIG laser. (Author)

A67-29389
GROUND STATE ESR MEASUREMENTS OF RUBY DURING LASER ACTION.
Takashi Igarashi (Ministry of Posts and Telecommunications, Radio Research Laboratory, Tokyo, Japan) and Alex Szabo (National Research Council, Radio and Electrical Engineering Div., Ottawa, Canada).
(Institute of Electrical and Electronics Engineers, International Quantum Electronics Conference, 4th, Phoenix, Ariz., Apr. 12-15, 1966, Paper.)
IEEE Journal of Quantum Electronics, vol. QE-3, Apr. 1967, p. 143-150. 50 refs.

The use of electron spin resonance for measurement of the ground state population (GSP) of Cr^{3+} in a ruby rod during optical pumping is described. For a 7.7-cm-long rod at 90°K and a mirror reflectance product $R_1R_2 > 0.08$, the GSP at laser threshold was found to be 55 ± 5% in good agreement with theory and previous optical measurements. At room temperature, a limiting value of approximately 30% for the GSP was approached at high pump energies. Observations of the relative $R_1(3/2)$, $R_1(1/2)$ thresholds at 90°K as a function of mirror reflectivity indicated that the ^2E excited state absorption cross section at the laser wavelength is less than 5×10^{-21} cm^2. Detection of total internal reflection oscillations in cooled ruby lasers from ESR observations is also described. (Author)

A67-29390
GAIN AND FLUORESCENCE CHARACTERISTICS OF FLOWING CO_2 LASER SYSTEMS.
Thomas F. Deutsch (Raytheon Co., Research Div., Waltham, Mass.).
IEEE Journal of Quantum Electronics, vol. QE-3, Apr. 1967, p. 151-155. 14 refs.

Single-pass gain has been measured for flowing CO_2, CO_2-N_2, CO_2-He, CO_2-N_2-He, and CO_2-N_2-H_2 mixes. The gain for CO_2-N_2 mixes varies as $d^{-0.9}$, where d is the tube diameter. The diameter dependence of the gain is less pronounced for CO_2-N_2-He mixes; a peak gain of 4.7 db/m was obtained in a 1/2 in. diam tube. Fluorescence data indicate that the upper laser level population is saturated at 100 ma in all cases. The addition of He, H_2, or O_2 depopulates the lower laser level; helium further increases the population of the upper laser level. The addition of CO increases the population of the upper laser level, probably by resonant transfer from the excited vibrational states of CO. (Author)

A67-29391
MODES IN UNSTABLE OPTICAL RESONATORS AND LENS WAVEGUIDES.
Anthony E. Siegman and Raymond Arrathoon (Stanford University, Dept. of Electrical Engineering, Stanford, Calif.).
IEEE Journal of Quantum Electronics, vol. QE-3, Apr. 1967, p. 156-163. 7 refs.
Contract No. AF 33(615)-1411.

Optical resonators and/or lens waveguides are "unstable" when they have divergent focusing properties such that they fall in the unstable region of the Fox and Li mode chart. Although such resonators have large diffraction losses, their large mode volume and good transverse-mode discrimination may nonetheless make them useful for high-gain diffraction-coupled laser oscillators. A purely geometrical mode analysis (valid for Fresnel number $N = \infty$) shows that the geometrical eigenmodes of an unstable syste are spherical waves diverging from unique virtual centers. As Burch has noted, the higher-order transverse modes in the geometrical limit have the form $u_n(x) = x^n$ with eigenvalues $\gamma_n = 1/M^{n+1/2}$, where M is the linear magnification of the spherical wave per period. The higher-order modes have nodes on-axis only, and there is substantial transverse-mode discrimination. More exact computer results for finite N show that the spherical-wave phase approximation remains very good even at very low N, but the exact mode amplitudes become more complicated than the geometrical results. The exact mode loss vs N exhibits an interesting quasi-periodicity, with $n = 0$ and $n = 2$ mode degeneracy occurring at the loss peaks. Defining a new equivalent Fresnel number based on the actual spherical waves rather than plane waves shows that the loss peaks occur at integer values of N_{eq} for all values of M. (Author)

A67-29392

CONTINUOUS SECOND-HARMONIC GENERATION OF λ2572 Å USING THE ARGON II LASER.

E. F. Labuda and A. M. Johnson (Bell Telephone Laboratories, Inc., Electron Devices Development Dept., Murray Hill, N. Y.).

IEEE Journal of Quantum Electronics, vol. QE-3, Apr. 1967, p. 164-167. 20 refs.

Continuous second-harmonic generation of λ2572 Å in KDP has been observed using the λ5145 Å AII laser transition. Optimum phase matching between the harmonic and fundamental beams, normal to the optic axis, was obtained at -13.7°C. The dependence of harmonic power on crystal temperature and on the degree of focusing of the fundamental beam was measured and compared with the theory of Boyd and Kleinman. Calculations indicate that if the axial modes of the AII laser are AM phase locked, then ~100 mw at λ2572 Å can be obtained for ~1.0 watt at λ5145 Å with crystal lengths of a few centimeters. Enhancements of average second-harmonic power of ~30 have been observed resulting from phase locking of the modes. (Author)

A67-29393

OBSERVATION OF THE OUTPUT OF A CO_2 LASER BY A HIGH-RESOLUTION THERMOGRAPHIC SCREEN.

T. J. Bridges and E. G. Burkhardt (Bell Telephone Laboratories, Inc., Murray Hill, N. J.).

IEEE Journal of Quantum Electronics, vol. QE-3, Apr. 1967, p. 168, 169.

Description of work with CO_2 lasers at 10.6 μ wavelengths requiring high resolution and short time constants. The thermal viewing screens using the so-called thermographic effect, described by McGee and Heilos, were modified by contacting them onto an aluminum block which acts as a heat sink. It is pointed out that the high contrast of the screen in its present form is a possible disadvantage. Thus a small range of power densities is sufficient to cover the whole range of indication from full brightness to black. The time constant of the screen was estimated to be ≈ 1/10 sec. A power density of ≈ 300 mw per cm^2 gave a good image in a dark room. This sensitivity is adequate for many CO_2 laser applications. An increase in sensitivity by a factor of two was obtained by increasing the mylar thickness to 5 mils. The resolution was very little affected, but the time constant was slightly increased. M.M.

A67-29394

PRECAUTIONS REQUIRED WHEN USING A CONTINUOUS GAS FLOW IN HIGH-CURRENT ION LASERS.

B. A. See, W. Garwoli, and J. L. Hughes (Department of Supply, Weapons Research Establishment, Salisbury, Australia).

IEEE Journal of Quantum Electronics, vol. QE-3, Apr. 1967, p. 169-170.

Description of a continuous gas flow used to overcome many of the problems arising from outgassing in ion lasers. The continuous gas flow sweeps out the impurities as they are formed, particularly at high direct currents. At low direct currents, the argon gas is led into the laser from the anode end and taken out halfway along the recirculating loop. This parallel flow system gives the optimum output from the laser. Since one cylinder of argon has lasted many months, the technique represents a considerable improvement as a means of reducing the gas pressure gradient while maintaining a steady output. M.M.

A67-29395

PULSED LASER EMISSION FROM HELIUM AT 95 μm.

L. E. S. Mathias, A. Crocker, and M. S. Wills (Ministry of Defence /Navy/, Services Electronics Research Laboratory, Baldock, Herts., England).

IEEE Journal of Quantum Electronics, vol. QE-3, Apr. 1967, p. 170. 11 refs.

Description of strong stimulated emission at a wavelength of 95 μ which was obtained from a pulsed electrical discharge through helium at low pressure. The transition was identified and the wavelength was measured accurately with an interferometer. The radiation proved to be very useful in setting up and calibrating spectroscopic equipment. This appears to be the first instance of laser emission from helium in the far IR. M.M.

A67-29467 #

A MICHELSON LASER INTERFEROMETER [LAZERNYI INTERFEROMETR MAIKEL'SONA].

Iu. D. Kolomnikov, V. N. Lisitsyn, and V. P. Chebotaev.

Optika i Spektroskopiia, vol. 22, May 1967, p. 828-831. In Russian.

Description of a triple-mirror Michelson interferometer with a laser source. A diagram of the arrangement is given together with a discussion of the laser and the optical equipment of the interferometer. The operation of the interferometer is analyzed in terms of equations for the wave amplitude of observed beams. A study is made of the frequency and wavelength of the beam, the coefficient of refraction, the coefficient of separation at the glass plane, and the distances between surfaces. The modulation of the laser beam by mirror agitation is discussed. T.M.

A67-29468 #

PARAMETRIC RESONANCE IN THE NONLINEAR THEORY OF THE ZEEMAN EFFECT [O PARAMETRICHESKOM REZONANSE V NELINEINOI TEORII EFFEKTA ZEEMANA].

N. N. Rozanov.

Optika i Spektroskopiia, vol. 22, May 1967, p. 831-834. 11 refs. In Russian.

Analysis of some nonlinear and parametric phenomena occurring in gas lasers placed in a magnetic field. In connection with previous studies, conducted within the framework of Lamb's (1964) theory, of the abnormal behavior of the pulsation frequency between oscillations of various polarizations, this study is concerned with the discovery that in the region of damping the pulse spectrum contains a series of harmonics usually associated with certain modulation processes. This occurrence is examined from the point of view of the nonlinear theory of oscillations for the purpose of demonstrating the possibility of observing the parametric effect in a gas laser located simultaneously in a stationary and a variable magnetic field. T.M.

A67-29469 #

A LASER UNDER THE ACTION OF AN EXTERNAL SIGNAL [OPTICHESKII KVANTOVYI GENERATOR POD DEISTVIEM VNESHNEGO SIGNALA].

R. F. Boikova and E. E. Fradkin.

Optika i Spektroskopiia, vol. 22, May 1967, p. 834-837. In Russian.

Analysis of the principles involved in observing the process of emission in a laser under the influence of an external signal. A study is made of the problem of the competition between the amplifica-

tion mode and the parasitic generation arising at a resonant frequency in a feedback amplifier. The amplification field in a two-frequency laser is considered in terms of the sum of the amplification field operating at the frequency of the external signal and the generation field at the resonant frequency. The total field is examined for both a traveling-wave generator and a standing-wave generator. A series of equations is presented whose solution indicates that the application of an external signal assists in the suppression of the resonant frequency. T.M.

A67-29474
MEASUREMENT OF THE DENSITY OF A DEVELOPING PLASMA OBTAINED THROUGH LASER IONIZATION BY MEANS OF A FABRY-PEROT INTERFEROMETER [MESURE DE LA DENSITE D'UN PLASMA EN EVOLUTION OBTENU PAR IONISATION LASER A L'AIDE DE L'INTERFEROMETRE FABRY-PEROT].
Daniel Bize, Terenzio Consoli, Lucien Slama, Pierre Stevenin, and Micheline Zymanski (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Services de Physique Appliquée, Gif-sur-Yvette, Seine-et-Oise, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 17, Apr. 24, 1967, p. 1235-1238. In French.

Measurement of the development of the plasmoid density of a plasma obtained by means of laser ionization. A Fabry-Pérot interferometer operating on a wavelength of 2 mm makes this measurement possible in a phase in which an optical method cannot easily be used. M.M.

A67-29481
DYNAMIC HOLOGRAPHY.
Jacques Monneret (Besançon, Université, Laboratoire d'Optique, Besançon, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 18, May 3, 1967, p. 1306-1308. 5 refs. In French.

Transposition into holography of certain methods of optical visualization (interferometry, phase contrast, 3-dimensional photoelasticimetry). A dynamic study of phenomena evolving in the course of time, based on these methods, is accomplished by linking an ultrahigh-speed camera to a solid-state laser furnishing pulses in the course of each of which a hologram is recorded. F.R.L.

A67-29484
INFLUENCE OF PUMP-INDUCED MATERIAL INHOMOGENEITIES ON GIANT PULSE EVOLUTION.
Dieter Roess (Siemens AG, Zentrallaboratorien, Munich, West Germany).
Journal of Applied Physics, vol. 38, Mar. 15, 1967, p. 1705-1709. 14 refs.
Research supported by the Bundesministerium für Wissenschaftliche Forschung.

Examination of the influence of pump-induced material inhomogeneities on the evolution of giant pulses, showing that the time evolution of the giant pulse can be studied by analysis of the laser rate equations. In a giant-pulse laser rod, an inhomogeneous excess inversion across the rod diameter will lead to a nonuniform growth rate of the photon avalanche when the transverse modes are not tightly coupled. For a model inversion distribution the resulting giant-pulse elongation is calculated. The radial time dispersion can be compensated by a radius-dependent resonator feedback or by transverse mode coupling. The influence of thermal resonator curvature on the decoupling of transverse modes is discussed. P.v.T.

A67-29497
MODE CONTROL IN A RUBY LASER.
Mark Daehler, G. A. Sawyer, and E. L. Zimmermann (California, University, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.).
Journal of Applied Physics, vol. 38, Mar. 15, 1967, p. 1980.

Description of observations made while using a giant pulse laser as a light source in a plasma scattering experiment. It was necessary to keep the laser emission within a spectral range of 0.05 Å. It was possible to control the multiple modes of a commercial laser (the Korad K-1Q) to meet this requirement by making some modifications, but without the use of a saturable dye. It is pointed out that a considerable advantage lies in the fact that this method of mode control does not require the painstaking and continual concentration adjustments required of a saturable dye. P.v.T.

A67-29498
OPTICAL IMAGING OF A COMPLEX ULTRASONIC FIELD BY DIFFRACTION OF A LASER BEAM.
H. V. Hance, J. K. Parks, and C. S. Tsai (Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Research Laboratories, Palo Alto, Calif.).
Journal of Applied Physics, vol. 38, Mar. 15, 1967, p. 1981-1983.

Description of a new method of producing an optical image of a complex ultrasonic field by using the phenomenon of light diffraction by ultrasonic waves. As a basis for describing the imaging method, an analysis made of the diffraction of a thin, plane-wave light beam by a uniformly divergent (spherical longitudinal ultrasonic wave is summarized. This form of elementary wave was chosen because any arbitrary ultrasonic field can be considered to originate from a distribution of point sources located on a conveniently chosen reference surface. If a corresponding set of optical images of these elementary sources and their resulting fields can be produced, an electromagnetic replica of the original total ultrasonic field will have been created. P.v.T.

A67-29499
ANALYSIS OF THE EPR SPECTRUM OF RUBY USING VARIANCE TECHNIQUES.
C. J. Kirkby and J. S. Thorp (Durham, University, Dept. of Applied Physics, Durham, England).
Journal of Applied Physics, vol. 38, Mar. 15, 1967, p. 1985, 1986. 7 refs.

Description of variance techniques used in analyzing the EPR spectrum in ruby. In the study of broadening mechanisms of the EPR spectra, a major problem has been to separate the Gaussian and Lorentzian components from the observed lineshapes. The potentialities of variance techniques for this purpose are outlined. The results of this study show how the Gaussian and Lorentzian components can be separated in a situation where both are present in the observed lineshape. Assuming a Gaussian distribution of crystalline misorientations and strain, the broadening due to these imperfections will be revealed as an increase in width of the Gaussian component derived by the variance method; work is proceeding in this direction. P.v.T.

A67-29511 #
OPERATION OF A GALLIUM ARSENIDE DIODE LASER WITH AN EXTERNAL RESONATOR USING A BREWSTER WINDOW.
E. Mohn, R. F. Broom, Ch. Deutsch, and J. Hatz (Bern, Universität, Institut für angewandte Physik, Berne, Switzerland).
Physics Letters, vol. 24A, May 22, 1967, p. 561, 562.

Description of a GaAs laser diode generating oscillations in an external cavity of 17 mm length. The brewster window is found to be most effective in suppressing modes within the crystal itself. The arrangement of diode with brewster window and external cavity has proved relatively simple to align, stable in operation, and completely free from modes within the diode itself. P.v.T.

A67-29512 #
RESONANCE-EFFECTS IN THE OUTPUT OF A He-Ne LASER WITH AN AXIAL MAGNETIC FIELD.
G. Hermann and A. Scharmann (Giessen, Universität, I. Physikalisches Institut, Giessen, West Germany).
Physics Letters, vol. 24A, May 22, 1967, p. 606. 5 refs.

Measurement of the output of a He-Ne laser as a function of the strength of an axial magnetic field. This function has intensity dips

in the regions where combination frequencies of different modes are in resonance with the double Larmor frequency. A theoretical discussion of the neon transition ($J = 1 \rightarrow J = 2$) shows that the form of the dips in the spectrum of Larmor frequencies has practically the shape of the natural line. P.v.T.

A67-29513 #

PHOTON COUNTING STATISTICS OF LASER LIGHT.
G. Bédard (Rochester, University, Dept. of Physics and Astronomy, Rochester, N.Y.).
Physics Letters, vol. 24A, May 22, 1967, p. 613, 614. 13 refs.
USAF-supported research.

Derivation of simple expressions and recurrence relations for the photocount distribution, associated with the photodetection of laser light, as well as for its factorial moments. Use is made of the probability density for the laser light intensity, as provided by Risken's analysis of the dynamics of laser oscillators. P.v.T.

A67-29642 #

THE GENERATION OF LARGE PULSES IN A RUBY LASER BY THE METHOD OF A ROTATING MIRROR AT LOWER FREQUENCIES [GENERACE OBŘÍCH PULSŮ NA RUBÍNOVÉM LASERU METODOU ROTUJÍCÍHO ZRCADLA ZA NIŽŠÍCH RYCHLOSTÍ].
Vl. Nováček and J. Matoušek (Československá Akademie Věd, Ústav Přístrojové Techniky, Brno, Czechoslovakia).
Jemná Mechanika a Optika, vol. 12, May 1967, p. 141-144, 153.
In Czech.

Description of an experiment consisting of the generation of high-performance pulses of extremely short duration, in a ruby laser by utilizing the rotating-mirror technique. A preliminary discussion is given of the fundamental concepts of laser action in a ruby containing chromium additions. The equipment utilized in the experimental arrangement is described in detail. It consisted of a ruby 1 cm in diameter and 10 cm long with 0.05% Cr content. The modulation of the regeneration was performed with the aid of a mechanical system of mirror rotation at one end of the ruby source. Additional equipment was utilized for measurements of pulse intensity and the quality of light emission. Experimental results calculated in the region between 8000 and 32,000 mirror revolutions per minute are presented in terms of output energy, consumed energy, pulse duration, and pulse intensity. The maximum reproducible outputs of the first pulse exceeded 6 Mw. T.M.

A67-29665

ANOMALOUS TEMPERATURE-DEPENDENCE OF THE THRESHOLD OF A QUASI-CONTINUOUSLY OPERATED RUBY LASER [EINE ANOMALE TEMPERATURABHÄNGIGKEIT DER SCHWELLE BEI EINEM QUASIKONTINUIERLICH BETRIEBENEN RUBINLASER].
G. Zeidler (Siemens AG, Zentral-Laboratorium für Nachrichtentechnik, Munich, West Germany).
Zeitschrift für Naturforschung, Ausgabe A, vol. 22, Apr. 1967, p. 566-570. 10 refs. In German.
Research supported by the Bundesministerium für Wissenschaftliche Forschung.

Measurement of the threshold temperature variation, output power, and emission spectrum of short ruby crystals operated in the quasi-continuous mode for various temperatures of the cooling agent. Contrary to expectations, it is found that at cooling-agent temperatures below -5°C the threshold of a Verneuille crystal exhibited an abrupt increase, while in the case of a Czochralski-grown crystal the threshold decreased in accordance with the theory. This effect is attributed to excitation processes in high-lying energy levels and to pumping-induced absorption centers, which depend on the production process and the lifetime of which increases with decreasing temperature. V.P.

A67-29682

MATERIAL PROCESSING IN MICROELECTRONICS WITH THE AID OF LASER BEAMS [MATERIALBEARBEITUNG IN DER MIKROELEKTRONIK MIT HILFE VON LASERSTRAHLEN].
W. Raetzel (Siemens AG, Wernerwerk für zentrale Aufgaben, Munich, West Germany).
Internationale Elektronische Rundschau, vol. 21, no. 5, 1967, p. 116-118. In German.

Study of the use of solid-state lasers for the processing and automatic handling of components in the electronic field. A brief review of the mode of operation of the laser is presented, followed by a description of a material-processing laser. Power density, pulse frequency, and focusing spot are discussed. It is pointed out that the laser is especially suited for welding and soldering microelectronic components. R.B.S.

A67-29701 #

POLARIZATION OF RUBY LASER RADIATION [O POLIARIZATSII IZLUCHENIIA RUBINOVOGO LAZERA].
A. I. Alekseev and Iu. P. Nikitin (Moskovskii Inzhenerno-Fizicheskii Institut, Moscow, USSR).
Fizika Tverdogo Tela, vol. 9, May 1967, p. 1309-1315. 9 refs.
In Russian.

Study of the nature of radiation polarization in a ruby laser with a resonator shaped like a rectangular parallelepiped. The polarization is traced to the interaction between the active impurity atoms and the macroscopic electromagnetic field of the single-axis ruby crystal. Equations are derived to describe the electromagnetic processes occurring in a single-axis crystal of given volume, having the form of a parallelepiped and containing a given number of two-level impurity atoms. The directions of the polarization vector found analytically and experimentally, are in good agreement. V.Z.

A67-29704 #

LASER RADIATION ABSORPTION AND SEMICONDUCTOR BREAKDOWN [POGLOSHCHENIE LAZERNOGO IZLUCHENIIA I RAZRUSHENIE V POLUPROVODNIKAKH].
A. A. Grinberg, R. F. Mekhtiev, S. M. Ryvkin, V. M. Salmanov, and I. D. Iaroshetskii (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR; Akademiia Nauk Azerbaidzhanskoi SSR, Institut Fiziki, Baku, Azerbaidzhan SSR).
Fizika Tverdogo Tela, vol. 9, May 1967, p. 1390-1397. In Russian.

Discussion of the absorption of laser radiation in semiconductors and of the damage they sustain in the process. The various mechanisms of semiconductor breakdown involved are considered with special attention to the one which is due to the heat of the nonradiative recombination of the electron-hole pairs produced by laser radiation. The laser radiation absorption by free nonequilibrium current carriers is also noted as one of the causes of semiconductor breakdown. V.Z.

A67-29721 #

TEMPERATURE MEASUREMENT OF RUBY LASER RODS DURING PUMPING FROM THE VARIATION IN BIREFRINGENCE [IZMERENIE TEMPERATURY RUBINOVYKH STERZHNEI OKG VO VREMIA NAKACHKI PO IZMENENIIU DVOINOGO LUCHEPRELOMLENIIA].
A. P. Veduta and A. M. Leontovich (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Zhurnal Tekhnicheskoi Fiziki, vol. 37, May 1967, p. 942-946.
8 refs. In Russian.

Description of temperature measurements of ruby laser rods during pulsed pumping, using the dependence of the birefringence on the temperature and the resulting thermoelastic stresses. The main principles of the technique are analyzed in terms of the temperature-dependent properties of a cylindrical ruby rod- namely, the modulus of elasticity, the coefficient of expansion, and the coefficient of photoelasticity. The equipment utilized in the experiment consisted of a He-Ne laser whose beam was directed through a ruby rod towards a motion picture camera. The results of temperature measurement on the axes of cylindrical ruby rods up to 12 cm l (long) in the presence of pumping energies of up to 15 kilo-joules are cited. These measurements were made at 300 and 77°K with an accuracy no less than 20%. A table is given listing results for rods of various lengths and diameters. T.M.

A67-29722 #

LASER OPERATING REGIMES WITH A RESONATOR Q-FACTOR DEPENDING ON THE RADIATION FIELD POWER [REZHIMY RABOTY KVANTOVYKH GENERATOROV S DOBROTNOST'IU REZONATORA, ZAVISIASHCHEI OT INTENSIVNOSTI POLIA IZLUCHENIIA].

V. N. Morozov and A. N. Oraevskii (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).

Zhurnal Tekhnicheskoi Fiziki, vol. 37, May 1967, p. 947-952. 9 refs. In Russian.

Discussion of laser radiation control techniques using saturation filters or an external negative feedback circuit to level radiation pulsations in the giant-pulse regime. Theoretically, these techniques are based on the nonlinear nature of the dependence of power losses, on the radiation field intensity, due to diffraction, dispersion and scattering. The performance of a vanadium phthalocyanine filter is analyzed in detail. V.Z.

A67-29729

MODULATION AND MODE LOCKING OF THE CONTINUOUS RUBY LASER.

K. Gürs (Battelle-Institut; Frankfurt, Universität, Frankfurt am Main, West Germany).

IEEE Journal of Quantum Electronics, vol. QE-3, May 1967, p. 175-180. 36 refs.
Research supported by the Bundesministerium für wissenschaftliche Forschung.

The continuous ruby laser is operated with an external mirror, a modulating crystal (KDP) and a Brewster plate as polarization switch are used in the inner beam path. Coupling of the axial laser modes occurs if the frequency of a voltage applied to the KDP crystal equals c/2L (≈ 30 MHz). Instead of assuming equal mode intensities, these intensities are calculated from the condition of a minimum of the total losses in the resonator. It is found that these intensities differ largely in their magnitudes. A curve calculated for six locked modes corresponds exactly to the measured emission curve. If a modulating frequency other than the frequency separation c/2L between adjacent longitudinal modes is chosen, the effect of the modulation on the stored energy within the laser averages out. Nevertheless, the intensity coupled out at the Brewster plate is modulated according to the term $(\varphi_1 + \varphi_0 \cos \omega t)^2$. Some results of this coupling modulation are presented. (Author)

A67-29730

PRELIMINARY MEASUREMENTS OF LASER SHORT-TERM FREQUENCY FLUCTUATIONS.

A. E. Siegman (Stanford University, Dept. of Electrical Engineering, Microwave Laboratory, Stanford, Calif.), Benedetto Daino (Fondazione Ugo Bordoni, Istituto Superiore P. T., Rome, Italy), and K. R. Manes.

IEEE Journal of Quantum Electronics, vol. QE-3, May 1967, p. 180-189. 5 refs.
Research supported by the Fondazione Ugo Bordoni and NATO; Contract No. DA-28-043-AMC-00446.

Measurements of the short-term frequency or phase fluctuations of two short stable single-frequency 6328 Å He-Ne lasers. The experimental apparatus used is described in detail. The results, which are all qualitatively compatible, and quantitatively in agreement to within better than a factor of two, indicate random Gaussian perturbation of the laser's instantaneous frequency by internal or environmental disturbances (plasma noise, acoustic noise, etc.) that have not yet been clearly identified. By improving these characteristics somewhat and operating one laser at a very much lower power level in order to enhance its quantum-phase fluctuations, it appears feasible to measure the ultimate quantum-frequency fluctuations caused by random walk of the oscillator phase under the influence of spontaneous emission. M.F.

A67-29731

FREQUENCY MODULATION AND DEMODULATION OF A GALLIUM ARSENIDE INJECTION LASER USING ULTRASONIC WAVES.

J. E. Ripper and C. G. Whitney (Massachusetts Institute of Technology, Dept. of Electrical Engineering and Center for Materials Science and Engineering, Materials Theory Group, Cambridge, Mass.).

IEEE Journal of Quantum Electronics, vol. QE-3, May 1967, p. 202, 203.
Army-ARPA-supported research.

Direct experimental verification of the feasibility of frequency modulating a semiconductor injection laser using ultrasonic waves as the modulator. The laser beam was demodulated to recover the information contained on it, a Fabry-Pérot interferometer being used to transform the frequency modulation into amplitude modulation. The frequency of the laser beam was changed by varying the dielectric constant in the laser with pressure. M.F.

A67-29732

STABILITY MEASUREMENTS OF CO_2-N_2-He LASERS AT 10.6 μm WAVELENGTH.

Charles Freed (Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Mass.).

IEEE Journal of Quantum Electronics, vol. QE-3, May 1967, p. 203-205. 11 refs.

Experimental investigation of the short-term stability of the beat frequency of two stable, single-frequency (TEM_{00q} mode) CO_2-N_2-He lasers. The stability observed is considered poor because of relatively bad environmental conditions. On at least one occasion, the beat-frequency fluctuation stayed well within the approximately 500 Hz resolution limit of a panoramic spectrum analyzer for several seconds, and the slow drift did not exceed a few kilohertz on a 1 kHz/cm display for several minutes. This observation shows that the conservative but more typical stability figures given previously can be improved with proper care and equipment. M.F.

A67-29758

POLARIZATION OF THE RADIATION EMITTED BY A NEODYMIUM-GLASS LASER.

Iu. I. Kruzhilin.

(Optika i Spektroskopiia, vol. 22, Jan. 1967, p. 115-118.) Optics and Spectroscopy, vol. 22, Jan. 1967, p. 60, 61. Translation.

Measurements were carried out to determine the position of the plane of polarization of radiation emitted by a neodymium-glass laser. The experimental arrangement is described. It is shown that the artificial anisotropy of the resonator has a stabilizing effect on the position of the plane of polarization. (Author)

A67-29759

EFFECT OF MISADJUSTMENT OF LASER RESONATOR MIRRORS ON THE ANGULAR DISTRIBUTION OF LASER RADIATION.

V. P. Kalinin and V. V. Liubimov.

(Optika i Spektroskopiia, vol. 22, Jan. 1967, p. 123-126.) Optics and Spectroscopy, vol. 22, Jan. 1967, p. 64-66. 5 refs. Translation.

The angular distribution of laser radiation and the variation in the direction of the beam of stimulated radiation as a function of the angle of misadjustment of the mirrors were studied experimentally at different lengths (500-2800 mm) and diameters (2.6-15 mm) of the laser resonator. It is shown that the spread of the angle of the generated beam for slight misadjustments is in good agreement with the theoretical estimate. Measurements of the deflection of the beam made it possible to estimate the magnitude of the loss in a resonator with misadjusted mirrors. (Author)

A67-29760

DETERMINATION OF THE SHAPE OF THE PULSES GENERATED BY A GAS LASER WITH MUTUAL SYNCHRONIZATION OF INTERMODAL BEATS.

L. N. Magdich.

(Optika i Spektroskopiia, vol. 22, Jan. 1967, p. 161, 162.) Optics and Spectroscopy, vol. 22, Jan. 1967, p. 83, 84. Translation.

Experiment in measuring extremely short pulses, generated by a He-Ne laser, by an optical method. The pulses generated by the

laser have a bell shape and a duration of 0.57×10^{-9} sec; the laser operates with mutual synchronization of intermodal beats achieved by a scanning Fabry-Pérot interferometer. The basic component of the arrangement is a Michelson interferometer. P.v.T.

A67-29788
KINETICS OF THE FORMATION AND HEALING OF DAMAGE CAUSED BY A LASER BEAM IN LITHIUM FLUORIDE SINGLE CRYSTALS.
N. V. Volkova, V. A. Likhachev, V. M. Salmanov, and I. D. Iaroshetskii (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR).
(Fizika Tverdogo Tela, vol. 8, Dec. 1966, p. 3595-3601.)
Soviet Physics - Solid State, vol. 8, June 1967, p. 2872-2876.
11 refs. Translation.
[For abstract see issue 05, page 867, Accession no. A67-17057]

A67-29816
TWO-PHOTON ABSORPTION IN ZnS.
E. Panizza (Rochester, University, College of Engineering and Applied Science, Institute of Optics, Rochester, N.Y.).
Applied Physics Letters, vol. 10, May 15, 1967, p. 265, 266. 8 refs.
Army-USAF-supported research.
Investigation of the two-photon absorption spectrum of ZnS at RT and LNT. The magnitude of the nonlinear absorption cross section is discussed with respect to pumping by means of two-photon absorption and with respect to second-harmonic attenuation in ZnS. Two-photon absorption limits the transparency of crystals subjected to high intensity, luminous fluxes and, in particular, the efficiency of second-harmonic generation in crystals which absorb at the sum frequency of the laser and the second-harmonic frequencies. The spectrum shows that attenuation of the second-harmonic via two-photon absorption must be particularly severe in the case of a ruby laser. P.v.T.

A67-29817
CONTINUOUSLY TUNABLE, NARROW-BAND ORGANIC DYE LASERS.
B. H. Soffer and B. B. McFarland (Korad Corp., Santa Monica, Calif.).
Applied Physics Letters, vol. 10, May 15, 1967, p. 266, 267.
ARPA-Navy-DOD-sponsored research.
Demonstration of efficient spectral narrowing and tunability over a wide spectral range in solid and liquid organic dye lasers, using diffraction gratings as cavity reflectors. This effect was demonstrated with members of the xanthene and carbocyanine dye families. The use of solid solutions of dyes in plastic as a practical dye laser material is discussed. It is expected that many related dye families will behave in a similar fashion and that the entire wavelength region from 347 mμ (ruby second harmonic) to about 1 μ could be practically spanned according to these techniques. P.v.T.

A67-29821
VOLUME EXCITATION OF AN ULTRATHIN CONTINUOUS-WAVE CdSe LASER AT 6900 Å OUTPUT.
M. R. Johnson, N. Holonyak, Jr., M. D. Sirkis, and E. D. Boose (Illinois, University, Dept. of Electrical Engineering and Dept. of Physics, Materials Research Laboratory, Urbana, Ill.).
Applied Physics Letters, vol. 10, May 15, 1967, p. 281, 282.
ARPA Contract No. SD-131; Contract No. AF 19(628)-4337.
Description of a continuous (CW) operation (at $T > 77^{\circ}K$) of an ultrathin CdSe platelet laser which is optically excited by a He-Ne laser. The pump power required is less than 50 mw and the laser output is at ~6900 Å. Due to experimental limitations, the power conversion efficiency was not measured. The possibility of duplicating the results obtained in this experiment throughout the entire visible spectrum on Cd(Se, S) platelets pumped with an argon laser or even with appropriate incoherent lamps is suggested. P.v.T.

A67-29879 *
SPECTROSCOPIC TEMPERATURE MEASUREMENTS ON LASER-PRODUCED FLAMES.
J. E. Mentall and R. W. Nicholls (Western Ontario, University, Dept. of Physics, London, Ontario, Canada).
Journal of Chemical Physics, vol. 46, Apr. 15, 1967, p. 2881-2885. 22 refs.
Research supported by the National Research Council of Canada; Grants No. AF AFOSR 62-236A; No. NsG-349.
Time-integrated spectroscopic intensity measurements have been made on the flame produced by the interaction of a focused ruby laser with powdered solids. Target materials used were $Ba(AlO_2)_2$, CaS, C, and Al microspheres. Excitation temperatures of 24,000 and 9000°K have been inferred from the Ba and Ca spectra. Vibrational and rotational temperatures for AlO, C_2, and CN were found to lie in the range from 3600 to 5600°K. It is probable that excitation of the atomic and molecular spectra result from collisions between the emitting species and free electrons which have been superheated by absorption of a small fraction of the laser-beam energy. (Author)

A67-29901
1967 SWIEEECO RECORD; INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, ANNUAL SOUTHWESTERN CONFERENCE AND EXHIBITION, 19TH, DALLAS, TEX., APRIL 19-21, 1967, TECHNICAL PROGRAM PAPERS.
Edited by A. A. Dougal (Texas, University, Dept. of Electrical Engineering, Austin, Tex.).
New York, Institute of Electrical and Electronics Engineers, Inc., 1967. 829 p.
Members, $6.00; nonmembers, $9.00.

CONTENTS:

A67-29902

A TECHNIQUE FOR MEASURING THE DENSITY OF ELECTRONS IN PLASMAS USING SELF-FOCUSED LASER BEAMS.

A. R. M. Rashad (Memphis State University, School of Engineering, Memphis, Tenn.).

IN: 1967 SWIEEECO RECORD; INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, ANNUAL SOUTHWESTERN CONFERENCE AND EXHIBITION, 19TH, DALLAS, TEX., APRIL 19-21, 1967, TECHNICAL PROGRAM PAPERS. [A67-29901 15-09]
Edited by A. A. Dougal.
New York, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 2-1-1 to 2-1-6. 7 refs.

Determination of the electron density in plasmas by using self-focused laser beams. An equation is given for determining the electrons density, and the difficulties encountered in the calculation of the parameter γ, describing the interaction of the high-frequency electromagnetic radiation from the laser beam with the plasma, are indicated. It is believed that the technique can also be used for measuring the temperature of electrons in plasmas when accurate theoretical studies are performed for the calculation of γ. B.B.

A67-29903

MACH-ZEHNDER OPTICAL INTERFEROMETRY OF LASER INDUCED DISCHARGES IN HIGH PRESSURE GASES.

Frederic Weigl, Otto M. Friedrich, Jr., and Arwin A. Dougal (Texas, University, Dept. of Electrical Engineering, Austin, Tex.).

IN: 1967 SWIEEECO RECORD; INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, ANNUAL SOUTHWESTERN CONFERENCE AND EXHIBITION, 19TH, DALLAS, TEX., APRIL 19-21, 1967, TECHNICAL PROGRAM PAPERS. [A67-29901 15-09]
Edited by A. A. Dougal.
New York, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 2-2-1 to 2-2-8.
Research supported by the Texas Atomic Energy Research Foundation and DOD.

Discussion of the use of the Mach-Zehnder interferometer in time- and space-resolved measurements of high-density, laser-induced plasmas. The system is shown to be capable of detecting relatively large changes in refractive index over very short path lengths. Time resolution of the data is obtained by using a giant pulse laser as the light source of the interferometer, thus allowing interferogram exposure times of 50 nsec. B.B.

A67-29910
LASER OSCILLATION ON ELECTRONIC TRANSITIONS IN NEUTRAL N_2 AND CO.
R. B. Allen, T. F. Whittaker, and A. A. Dougal (Texas, University, Dept. of Electrical Engineering and Laboratory for Electronics, and Laboratory for Related Science Research, Austin, Tex.).
IN: 1967 SWIEEECO RECORD; INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, ANNUAL SOUTHWESTERN CONFERENCE AND EXHIBITION, 19TH, DALLAS, TEX., APRIL 19-21, 1967, TECHNICAL PROGRAM PAPERS. [A67-29901 15-09]
Edited by A. A. Dougal.
New York, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 5-1-1 to 5-1-8. 7 refs.
Grant No. AF AFOSR 766-67.

Experimental study of laser action in the N_2 second positive band system, the N_2 first positive band system, and the CO Ångstrom band system. Conventional, coaxial, and crossed-field laser discharge tube geometries have been used. The effect of various rare gas mixtures on the N_2 and CO laser output has been investigated and experimental results have been presented. The general trend observed for all N_2-rare gas and CO-rare gas mixtures studied was a decrease in the relevant laser output as the rare gas impurity concentration was increased. In all cases, the primary effect of the rare gases is to change the electron density or energy distribution during gas breakdown in such a way as to reduce the selective excitation of the molecular upper laser levels. R.B.S.

A67-29911
NUMBER DENSITY DETERMINATION IN THE ATMOSPHERE OF O_2, H_2O AND CO_2 GAS CONSTITUENTS BY USE OF A HIGH INTENSITY LASER BEAM.
D. L. Dobbins and A. H. LaGrone (Texas, University, Austin, Tex.).
IN: 1967 SWIEEECO RECORD; INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, ANNUAL SOUTHWESTERN CONFERENCE AND EXHIBITION, 19TH, DALLAS, TEX., APRIL 19-21, 1967, TECHNICAL PROGRAM PAPERS. [A67-29901 15-09]
Edited by A. A. Dougal.
New York, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 5-3-1 to 5-3-10. 16 refs.
NSF Grant No. GA-767.

A method is developed whereby number densities of several of the atmospheric gas constituents may be determined as a function of altitude. The method dictates the use of two laser wavelengths, one occurring in an absorption region of the gas in consideration and one occurring in a spectral region where no absorption takes place. Returned scattered signals are collected and used along with absorption line strength and line width to determine the number density. The method described affords an indirect way of determining number densities of a specific constituent of the atmosphere by electromagnetic probing. (Author)

A67-29912
ULTRASONIC DEVICES FOR COHERENT OPTICAL SYSTEMS.
D. T. Bell, Jr. and E. T. Kidd (Texas Instruments, Inc., Apparatus Div., Dallas, Tex.).
IN: 1967 SWIEEECO RECORD; INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, ANNUAL SOUTHWESTERN CONFERENCE AND EXHIBITION, 19TH, DALLAS, TEX., APRIL 19-21, 1967, TECHNICAL PROGRAM PAPERS. [A67-29901 15-09]
Edited by A. A. Dougal.
New York, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 5-4-1 to 5-4-8. 8 refs.

Discussion of recent advances in cadmium sulfide transducers, array transducer design, and light modulating materials. These new devices make it feasible to scan laser beams over more than 1000 spots at high rates and to perform signal processing functions on microwave signals. Background material on ultrasonic diffraction phenomena is given. R.B.S.

A67-29913
OPTICAL RANGING SYSTEM EMPLOYING A HIGH POWER INJECTION LASER.
Walter Koechner (U.S. Army, Electronics Command, Fort Monmouth, N.J.).
IN: 1967 SWIEEECO RECORD; INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, ANNUAL SOUTHWESTERN CONFERENCE AND EXHIBITION, 19TH, DALLAS, TEX., APRIL 19-21, 1967, TECHNICAL PROGRAM PAPERS. [A67-29901 15-09]
Edited by A. A. Dougal.
New York, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 5-6-1 to 5-6-8.

The paper describes the performance of a small lightweight optical ranging system employing a pulsed gallium arsenide laser diode transmitter with peak powers up to 100 watts at room temperature. Range is obtained by measuring transit time of the light pulse with a digital or analog counter. The maximum range which could be obtained was 700 m against 30% diffuse reflecting targets. (Author)

A67-29914
A LARGE SCREEN COLOR TELEVISION LASER DISPLAY.
C. E. Baker and C. M. Alsabrook (Texas Instruments, Inc., Dallas, Tex.).
IN: 1967 SWIEEECO RECORD; INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, ANNUAL SOUTHWESTERN CONFERENCE AND EXHIBITION, 19TH, DALLAS, TEX., APRIL 19-21, 1967, TECHNICAL PROGRAM PAPERS. [A67-29901 15-09]
Edited by A. A. Dougal.
New York, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 5-7-1 to 5-7-8.
Contract No. AF 30(602)-3910.

Description of a color television laser display. The instrument was constructed by using a neon-helium and an argon-ion laser in a unique modulation and scanning system. A table is given showing the dominant transition with major amount of output power for various types of lasers. The light modulator used in the display is a transverse-field Pockel's effect device constructed from 45° Z-cut crystal of potassium deuterium phosphase (KD*P), and solid-state amplifiers are used to drive it. A two-axis sinusoidal scanner driven with quadrature sinusoidal waveforms, producing a circular Lissajous scan pattern, comprises part of the display. The color display is significant in that it shows the feasibility of using lasers in full-color large-screen command and control displays. R.B.S.

A67-29962 #
NEW USES FOR NUCLEAR ENERGY IN OUTER SPACE.
Paul Harteck and Seymour Dondes (Rensselaer Polytechnic Institute, Troy, N.Y.).
American Astronautical Society, Annual Meeting, 13th, Dallas, Tex., May 1-3, 1967, Paper 67-115. 13 p. 8 refs.
Members, $0.75; nonmembers, $1.50.
AEC Contract No. AT(30-3)-321.

Discussion of the use of nuclear reactors in space environments for chemical synthesis and laser action. Chemonuclear developments which have taken place over the last decade are reviewed. Chemical compounds and simple gases which may be produced by chemonuclear means in outer space are cited, including oxygen, nitrogen dioxide, nitrous oxide, ammonia, carbon monoxide, and hydrogen. The effect of the decrease in pressure found in space environments on animals and plants is briefly discussed. The use of radioisotopes in small power-generating plants is presented as one method for solving the power-supply problem. R.B.S.

A67-30003 #
SPECTROSCOPIC STUDY OF A GAS DISCHARGE FOR ARGON ION LASERS [SPEKTROSKOPICHESKOE ISSLEDOVANIE GAZOVOGO RAZRIADA DLIA ARGONOVYKH IONNYKH OPTICHESKIKH KVANTOVYKH GENERATOROV].
V. F. Kitaeva, Iu. I. Osipov, and N. N. Sobolev (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Akademiia Nauk SSSR, Doklady, vol. 172, Jan. 11, 1967, p. 317-319. In Russian.

Investigation of the gas discharge parameters in argon ion laser in an attempt to determine the level-inversion mechanism of such

lasers in a continuous or pulsed regime of generation. The H_β line contour during continuous generation is studied by crossing a spectrograph with a Fabry-Pérot interferometer. Determined from Stark effect photographs for the H_α and H_β lines, the discharge particle concentration in continuous generation has values ranging from ~3 to 4×10^{13} cm^{-3}. Tables are given for the operational and spectral characteristics of argon ion lasers, and a diagram for the discharge-atom and the ion temperature vs discharge current density is plotted. V.Z.

A67-30076 #

TAKING ABSORPTION INTO ACCOUNT IN THE STEADY STATE BEHAVIOR OF A REGENERATIVE TRAVELING-WAVE LASER [OB UCHETE POGLOSHCHENIIA V STATSIONARNOM REZHIME REGENERATIVNOGO OKU BEGUSHCHEI VOLNY].

N. D. Milovskii (Gor'kovskii Gosudarstvennyi Universitet, Nauchno-Issledovatel'skii Radiofizicheskii Institut, Gorki, USSR).

Radiofizika, vol. 10, no. 4, 1967, p. 583, 584. 7 refs. In Russian.

Study of the relation between the steady-state behavior of a regenerative traveling-wave laser and linear constant damping in the laser medium. It is demonstrated that it is not necessary to take into account the linear constant damping in the medium due to losses in the basic material when calculating the steady-state behavior of a regenerative traveling-wave laser. P.v.T.

A67-30086

LIQUID LASERS.

Alexander Lempicki (General Telephone and Electronics Laboratories, Inc., Quantum Physics Group, Bayside, N.Y.) and Harold Samelson (General Telephone and Electronics Laboratories, Inc., Bayside, N.Y.).

Scientific American, vol. 216, June 1967, p. 80-87, 89, 90.

Discussion of the use of a liquid as the active medium in a laser. The development of the laser is reviewed, and the general requirements for the onset of laser action are outlined. The use of rare-earth ions in liquid lasers is discussed, and liquid lasers based on a chelate structure are examined. It is pointed out that although the use of beta-diketone chelate cages was effective in achieving the first liquid laser, it ultimately limits this device as a practical system. These limitations are overcome by using the liquid selenium oxychloride ($SeOCl_2$). It is concluded that a liquid medium with nearly ideal fluorescence properties has been found and that the use of liquid lasers in the future is promising. M.F.

A67-30095

GENERAL STUDY OF MASER AMPLIFICATION BY AN ALKALI VAPOR [ETUDE GENERALE DE L'AMPLIFICATION MASER PAR UNE VAPEUR ALCALINE].

Francis Hartmann (Paris, Université, Ecole Normale Supérieure, Laboratoire de Physique, Paris, France).

Journal de Physique, vol. 28, Mar.-Apr. 1967, p. 288-296. 10 refs. In French.

Derivation of general relations governing the amplification and the development of oscillations in an optically pumped alkali vapor maser. An apparatus permitting experimental verification of these relations in the case of ^{85}Rb is described. The equations derived are applied to the study of amplification by ^{85}Rb vapor at 3035.7 MHz. M.F.

A67-30124

QUANTUMMECHANICAL SOLUTIONS OF THE LASER MASTER-EQUATION. I.

W. Weidlich, H. Risken, and H. Haken (Stuttgart, Technische Hochschule, Institut für theoretische Physik, Stuttgart, West Germany).

Zeitschrift für Physik, vol. 201, no. 4, 1967, p. 396-410. 15 refs.

Solution of the master equation for the statistical operator of a laser mode and active two-level atoms through use of the coherent-state representation of the light-field. The expression for the operator represents the most general symmetrical coupling of the light mode to all atoms and therefore contains the full influence of quantum fluctuations of the atomic system on the light mode. The system of equations can be solved almost exactly in the steady-state case and leads to a photon number distribution in the laser valid for arbitrary pumping. This distribution agrees with that found by a Fokker-Planck equation for moderate pumping and approaches the Poisson distribution for very high pumping. R.B.S.

A67-30147

GUIDE TO LASER MICROEMISSION SPECTRUM ANALYSIS [EINFÜHRUNG IN DIE LASER-MIKRO-EMISSIONSSPEKTRALANALYSE].

Horst Moenke and Lieselotte Moenke-Blankenburg.

Leipzig, Akademische Verlagsgesellschaft Geest und Portig KG (Technisch-Physikalische Monographien. Volume 21), 1966. 182 p. 142 refs. In German.
$6.85.

An account is given of how spectrum analyses may be run by using a laser to produce microemissions. Properties of lasers are briefly discussed, and the technique of Q-switching is reviewed. Various types of laser suitable for the creation of microemissions (lasers with outputs ranging from 1 to 20 watts per impulse) are described. Also treated are lasers designed with controlled negative feedback. Application possibilities in chemistry, minerology, geology, metallography, biology, medicine, archeology and criminology are investigated. The application of this technique to the analysis of a large number of elements is elucidated. R.B.S.

A67-30392

A MASER THAT WORKS IN RADAR BY AVOIDING SATURATION.

Simpson B. Adler (Radio Corporation of America, Defense Electronic Products, Missile and Surface Radar Div., Moorestown, N.J.).

Electronics, vol. 40, June 12, 1967, p. 115-120.

Description of a frequency shifting technique that uses an auxiliary coil to produce a magnetic field, thus making the maser transmitter more attractive for applications in high-power radar. Shifting the maser's frequency response while the radar pulse is transmitted overcomes the saturation problem and makes the maser more suitable for applications in high-powered radars. Interest in the amplifier is also increasing because of improved maser crystals and circuits. In addition, newly available superconducting magnets in small sizes can produce the large magnetic fields needed for maser operation, while reliable closed-cycle liquid helium cryogenic systems are available for the necessary cooling. P.v.T.

A67-30411

KEY ELEMENTS OF METROLOGY WITH LASER INTERFEROMETERS.

Anwar K. Chitayat (OPTOmechanisms, Inc., Plainview, N.Y.).

IN: AMERICAN SOCIETY FOR QUALITY CONTROL, ANNUAL TECHNICAL CONFERENCE, 21ST, CHICAGO, ILL., MAY 31-JUNE 2, 1967, TRANSACTIONS. [A67-30401 15-15]
Milwaukee, American Society for Quality Control, Inc., 1967, p. 467-474.

Description of the major items for consideration in the use of laser interferometers. The general sources of error in practical applications and methods for minimizing them are listed. A check list to be followed to ascertain accuracy consistent with the capability of the laser is developed. The major parameters affecting accuracy are graphically illustrated. The graphs can be used for quick estimation of errors caused by the environment and to place limits on alignment and offset errors. F.R.L.

A67-30426

MEASUREMENT OF THE LASER FREQUENCY CONTROL CHARACTERISTICS OF PIEZOELECTRIC TRANSDUCERS.

W. B. Jones, Jr. (Georgia Institute of Technology, School of Electrical Engineering, Atlanta, Ga.) and J. T. Ruscio (Bell Telephone Laboratories, Inc., Crawford Hill Laboratory, Holmdel, N.J.).

Applied Optics, vol. 6, June 1967, p. 1005-1009.

Description of instrumentation used for measuring the frequency of a laser by mounting one of the resonator mirrors on a piezoelectric transducer and applying a control voltage to the transducer. The magnitude and phase curves for a transducer for frequencies from 100 to 270 kHz are shown. There were no resonances below 100 kHz; the lowest computed resonant frequency for this disk is 360 kHz. Some of the resonances shown are believed to be due to the structure which supported the transducer, and some of them are due to higher harmonics in the voltage waveform which drives the transducer. It was found that the mechanical structure which supports the transducer has an important effect on the frequency control characteristics of the laser. M.M.

A67-30427

THE EFFECTS OF SCATTERING AND MIRROR REFLECTIVITY ON THE PERFORMANCE OF A RUBY LASER.

J. G. Edwards (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England).

Applied Optics, vol. 6, June 1967, p. 1011-1022. 22 refs.

Calculation of the output energy expected from a conventional ruby laser generator with plane parallel mirrors for a range of excitation energies, pulse lengths, mirror reflectivities, and losses due to absorption, scattering, and reflection. A linear dependence of output energy on excitation energy is expected only for a vanishingly small pulse length. The effects of localized losses such as those from reflections at the ends of the crystal are similar to scattering losses distributed through the crystal. The output-mirror reflectivity giving maximum output energy falls as the excitation energy and scattering increase but is typically 50 to 60%. The reduction in output caused by scattering is less for lower reflectivities. The angular distribution of light scattered from the ruby when lasing is measured by varying the resonator length to assess the scattering. The predictions of output energy are in good agreement with experiment for all the excitation energies, introduced scattering losses, and mirror reflectivities tried, except that above 70% reflectivity the prediction is as much as 60% low. M.M.

A67-30428

INFRARED MODULATOR UTILIZING FIELD-INDUCED FREE CARRIER ABSORPTION.

D. W. Peters (Stanford Research Institute, Menlo Park, Calif.).

Applied Optics, vol. 6, June 1967, p. 1033-1041. 23 refs.
USAF-sponsored research.

Description of an IR modulator which utilizes field-induced free-carrier absorption. The intensity of a light beam can be varied by a voltage-controlled absorption process within the modulator. The basic absorption process is free-carrier absorption. A modulation voltage is appropriately applied to a semiconductor crystal within the modulator-inducing carriers (holes or electrons) on the surface of the crystal. The light beam is reflected internally from the semiconductor surface where a fraction of the energy in the beam is absorbed by the surface space charge. The density of the space charge on the semiconductor surface is controlled by the applied voltage, which permits the amount of absorption to be varied. Theoretical relationships are derived which describe the modulation process. The theory is compared with the experiment with good agreement. (Author)

A67-30436

AN ELECTRONIC QUADRATURE TECHNIQUE FOR LASER INTERFEROMETRY.

J. W. Campbell and Virgil Erbert (Sandia Corp., Sandia Laboratory, Albuquerque, N. Mex.).

Applied Optics, vol. 6, June 1967, p. 1128, 1129.
AEC-supported research.

Description of an electronic technique capable of producing the necessary quadrature signal from a laser feedback interferometer (LFI) consisting of a CW laser and an external retroreflector. It is indicated that the Spectra Physics model 119 laser has the required electronic circuitry and, with a slight modification, can duplicate this function and provide the desired quadrature signal. The normal function of the circuitry in the Spectra Physics 119 is to stabilize the optical frequency of the laser output. Direct and quadrature signals are present at two convenient locations in the 119. The direct signal, which is available at the output of a photoelectric cell, is picked up at one of the cable connectors. The quadrature signal is picked up at a servo control circuit test point within the servo control module. The principle of electronic quadrature generation is briefly described. M.M.

A67-30437

DIRECT NONDESTRUCTIVE PUMPING OF RUBY LASERS BY CHEMICAL MEANS.

Chester L. Smith, Eugene Homentowski (Feltman Research Laboratories, Picatinny Arsenal, Dover, N.J.), and Charles Stokes (Temple University, Research Institute, Philadelphia, Pa.).

Applied Optics, vol. 6, June 1967, p. 1130, 1131.

Description of direct lasing of conventional ruby rods requiring a 200-joule xenon pump from the energy derived from a chemical reaction. The pump produces a brightness temperature of 6000 to 7000°K for periods of approximately 1 to 3 msec. The energy is obtained by a gaseous reaction in an enclosed cavity. This system has produced brightness temperatures to 8000°K, and some preliminary experiments indicate that the temperatures may go above this value. M.M.

A67-30460 #

INVESTIGATION OF LASER ACTION IN RUBY AND NEODYMIUM GLASS IN THE CASE OF AXICON PUMPING [ISSLEDOVANIE GENERATSII V RUBINE I NEODIMOVOM STEKLE PRI AKSIKONNOI NAKACHKE].

K. I. Krylov, N. E. Aver'ianov, A. S. Mitrofanov, A. S. Ter-Pogosian, and S. F. Sharlai (Leningradskii Institut Tochnoi Mekhaniki i Optiki, Leningrad, USSR).

Priborostroenie, vol. 10, no. 4, 1967, p. 9-11. In Russian.

Investigation of the laser action of ruby and neodymium-glass rods pumped by means of a system consisting of a cylinder with an axicon at each end. Although the axicon system has a lower output power than systems using strong pumping, it produces an emission field having a more homogeneous structure with a lower angular divergence. It is found that the output power can be increased by decreasing the lamp diameter. V.P.

A67-30461 #

RECTANGULAR LIGHT GUIDES FOR LOGIC ELEMENTS EMPLOYING INJECTION-TYPE SEMICONDUCTOR LASERS [PRIAMOUGOL'NYE SVETOVODY DLIA LOGICHESKIKH ELEMENTOV NA INZHEKTSIONNYKH POLUPROVODNIKOVYKH LAZERAKH].

L. M. Kuchikian (Leningradskii Institut Tochnoi Mekhaniki i Optiki, Leningrad, USSR).

Priborostroenie, vol. 10, no. 4, 1967, p. 20-23. 5 refs. In Russian

Development of a method for selecting rectangular light conductors which have a thickness comparable to the wavelength and which are designed to transfer energy from an injection-type semiconductor laser to a similar laser employed as a logic element. The ratio of the energy dissipated beyond the light conductor to the energy dissipated in the conductor is calculated. V.P.

A67-30605 #

EXPERIMENTS ON A FAR INFRARED CN LASER.

Shōzō Kon, Masanobu Yamanaka, Junya Yamamoto, and Hiroshi Yoshinaga (Nagoya University, Institute of Plasma Physics, Nagoya, Japan).

Japanese Journal of Applied Physics, vol. 6, May 1967, p. 612-619. 13 refs.

The characteristics of a CN laser with an external mirror operated with pulsed or dc discharges are described. The maximum laser output power is obtained with a coupling mirror of suitable dimension. The laser can oscillate when a metal mesh is used as a resonator mirror. Data on the laser output vs gas pressure flow rate, discharge current, and discharge energy are given. The

oscilloscope trace of the laser output shows that the oscillations occur as a train of spikes produced during the discharge for wide pulses, while, for very narrow current pulses, the oscillations occur in the afterglow period of the discharge and consist only of a single peak. (Author)

A67-30606 #
THEORETICAL CONSIDERATIONS OF THE THREE-LEVEL MASER DETECTOR FOR THE FAR-INFRARED.
Koichi Shimoda (Tokyo, University, Dept. of Physics, Tokyo, Japan).
Japanese Journal of Applied Physics, vol. 6, May 1967, p. 620-627. 11 refs.

Four different types of off-resonance operation of a three-level maser detector are discussed for the case where the pumping transition in a three-level system of a molecule does not exactly coincide with the output frequency of a maser oscillator. First, the use of pressure broadening is considered; secondly, a method which observes the double-quantum transition is considered; thirdly, a method which measures the change in population caused by double-quantum pumping is considered; and, finally, the level shift due to the far-infrared input is considered. It is found that the third method of double-quantum pumping, in which three waves are involved, is the most sensitive. A minimum detectable power of the order of 10^{-6} w/cm^2 with a resolving time of about 10^{-6} sec is expected in detecting maser outputs at the far-infrared differing from the resonant frequency of the detector by as much as 10 GHz. (Author)

A67-30607 #
OBSERVATION OF STIMULATED RAMAN EMISSION AND STIMULATED RAYLEIGH-WING SCATTERING FROM SELF-TRAPPED FILAMENTS OF A LASER BEAM.
Yoshifumi Ueda and Koichi Shimoda (Tokyo, University. Dept. of Physics, Tokyo, Japan).
Japanese Journal of Applied Physics, vol. 6, May 1967, p. 628-633. 11 refs.

The small-scale trapping of a laser beam and the frequency shift in Raman radiations were observed under various conditions of polarization. A cell of 15-cm length was filled with carbon disulfide and was excited by a Q-switched ruby laser with a mode selector. Simultaneous observations of the mode spectrum of the incident laser beam, the near-field pattern at the end of the Raman cell, and the frequency distribution of the scattered radiation are shown. They demonstrate direct and clear evidence of large frequency shifts in Raman radiation and Rayleigh wing scattering associated with self-focusing. (Author)

A67-30610 #
MODULATION AND DEMODULATION OF He-Ne LASER LIGHT AT 7 GHZ MICROWAVE FREQUENCY.
Sadao Nomura and Yukio Hasegawa (Hitachi, Ltd., Central Research Laboratory, Tokyo, Japan).
Japanese Journal of Applied Physics, vol. 6, May 1967, p. 651. 5 refs.

Transmission of television over a gas laser light beam with an ADP crystal at a modulating frequency of 7 GHz. The ADP crystal was chosen, because it has a suitable temperature dependence of the dielectric constant and the loss tangent along the c axis in the microwave region, although the electro-optical coefficient of ADP is smaller than KDP. F.R.L.

A67-30612 #
HOLOGRAPHIC GENERATION OF A CONTOUR MAP OF A DIFFUSELY REFLECTING SURFACE BY USING THE IMMERSION METHOD.
Tadao Tsuruta, Norio Shiotake (Nippon Kogaku K.K., Tokyo, Japan), Jumpei Tsujiuchi, and Kiyofumi Matsuda (Government Mechanical Laboratory, Tokyo, Japan).
Japanese Journal of Applied Physics, vol. 6, May 1967, p. 661, 662.

Description of a method of double-exposure holographic formation of a contour map over a diffusely reflecting surface of arbitrary shape by using an immersion method with two liquids of slightly different indices of refraction between the exposure. The method is capable of measuring engineering components of complicated shape. F.R.L.

A67-30809 #
MIXED SYSTEMS ON THE BASIS OF FLUORIDES AS NEW LASER MATERIALS FOR QUANTUM ELECTRONICS - THE OPTICAL AND EMISSION PARAMETERS.
A. A. Kaminskii, Iu. K. Voronko, and V. V. Osiko (Akademiia Nauk SSSR, Institut Kristallografii and Fizicheskii Institut, Moscow, USSR).
(Laser und ihre Anwendungen, Konferenz, Berlin, East Germany, Nov. 8-11, 1966, Vortrag.)
Physica Status Solidi, vol. 21, no. 1, 1967, p. K17-K21. 15 refs.

Spectroscopic investigation of laser emission, during ordinary and Q-switching generation at 77 and 300°K, of a new mixed-crystal type, based on fluorides. The absorption spectra were measured with a DFS-12 diffraction spectrometer. Illumination was provided from an incandescent lamp supplied by stabilized voltage. The luminescence spectra were measured in the same apparatus. The exciting light source was a standard 300-watt projection lamp, which was placed in one focus of an elliptical reflector. The emitted light was conducted by means of a quartz light guide to the entrance slit of the spectrometer. The wavelengths were measured with a DFS-8 grating spectrograph and a ZMR-3 monochromator. The temporal behavior of the emission was recorded with a photomultiplier and an InSb detector. P.v.T.

A67-30810 #
ANALYSIS OF THE OPTICAL SPECTRA AND STIMULATED RADIATION OF $Y_3Al_5O_{12}$-Nd^{3+} CRYSTALS.
A. A. Kaminskii, Kh. S. Bagdasarov, and L. M. Belyev (Akademiia Nauk SSSR, Institut Kristallografii, Moscow, USSR).
(Laser und ihre Anwendungen, Konferenz, Berlin, East Germany, Nov. 8-11, 1966, Vortrag.)
Physica Status Solidi, vol. 21, no. 1, 1967, p. K23-K29. 9 refs.

Investigation of the absorption, fluorescence, and stimulated-emission spectra of Nd^{3+} in $Y_3Al_5O_{12}$. From the comparison of these spectra at 300 and 77°K the energy level schemes for Nd^{3+} ions in $Y_3Al_5O_{12}$ crystals were constructed and an analysis of the optical spectra was made. The investigation has shown that the primary difficulty in obtaining continuous laser action, even in the case of very good crystal, lies in providing conditions such that the crystal does not heat up. Also of importance is the choice of the crystal diameter for a given concentration of Nd^{3+} and the matching of the crystal geometry to the geometrical parameters of the luminous portion of the excitation lamp. It is suggested that a generator operating quasi-continuously with a pyrotechnical excitation source could be constructed. P.v.T.

A67-30823 #
MEASUREMENTS OF CHANGES IN LENGTH DOWN TO 10^{-11} CM BY A TANDEM-LASER DEVICE.
G. Herziger and H. Lindner (Berlin, Technische Universität, I. Physikalisches Institut, Berlin, West Germany).
Physics Letters, vol. 24A, June 5, 1967, p. 684, 685.

Brief description of a laser device of high mechanical stability which is used to resolve changes in length down to 10^{-11} cm. As a second result of this work, the suitability of different piezoelectric materials for small modulations of mirror separations were investigated. R. B. S.

A67-30824 * #
ABSOLUTE FREQUENCY MEASUREMENT OF THE 190 μ AND 194 μ GAS LASER TRANSITIONS.
L. O. Hocker, D. Ramachandra Rao, and A. Javan (Massachusetts Institute of Technology, Dept. of Physics, Cambridge, Mass.).
Physics Letters, vol. 24A, June 5, 1967, p. 690, 691.
USAF-NASA-supported research.

Results of the measurement of the frequencies of the 190 and 194 μ laser transitions in a D_2O and C_2N_2 discharge. By harmonic mixing with a 70 GHz source, the frequencies were determined to be 1578.279 and 1539.756 GHz. R. B. S.

A67-30825 #
HIGH POWER ION LASERS WITH WALL-STABILIZED ARC DISCHARGE.
H. Boersch, G. Herziger, W. Seelig, and I. Volland (Berlin, Technische Universität, I. Physikalisches Institut, Berlin, West Germany).
Physics Letters, vol. 24A, June 5, 1967, p. 695, 696.

Investigation of Ar-laser operation in discharge tubes of 7, 10, and 15 mm ID without an axial magnetic field. The experimental values of the laser output vs discharge current are shown and compared to theoretical values. The threshold of laser action was found to be independent of tube diameter at nearly the same current density. Beyond the threshold range, the laser output increases quadratically with discharge current - as is known for small tube diameters. This behavior indicates that radiation trapping effects can be neglected. The maximum laser power obtained was found to be 100 watts. R.B.S.

A67-30891 #
INTERNAL MODULATION OF THE INFRA-RED LASER.
E. R. Mustel', V. N. Parygin, and V. S. Solomatin.
(Radiotekhnika i Elektronika, vol. 11, Dec. 1966, p. 2245-2247.)
Radio Engineering and Electronic Physics, vol. 11, Dec. 1966, p. 1984-1987. 5 refs. Translation.

A67-30897
EQUIVALENT RESISTANCE OF TRAVELING WAVE PHOTOTUBE AT LARGE MODULATION DEGREES.
Yooichi Fujii and Hiroshi Ogawa (Tokyo, University, Institute of Industrial Science, Tokyo, Japan).
Electronics and Communications in Japan, vol. 49, May 1966, p. 72-78. 15 refs. Translation.

Determination of the equivalent resistance of a traveling wave phototube (TWP) for a large modulation index. It is shown that the equivalent resistance may be calculated with ease if the beam current does not exceed a few hundred nanoamperes. For the low-current tube, the equivalent resistance is the same as the small-signal value. The effect of the helix loss is also considered, and it is shown that this effect can be taken into account by a simple modification. To verify the theoretical results, the equivalent resistance of a TWP was measured by using a gas-laser beam modulated at 1680 Mc by a potassium dihydrogen phosphate (KDP) modulator. It was noted that the equivalent resistance remains independent of the degree of modulation, and the absolute value of the resistance, including the effect of the helix loss, is in good agreement with the theoretically predicted value. R. B. S.

A67-30982
AN OPERATIONAL THEORY OF LASER-RADAR SELENODESY.
Robert L. Wildey (U.S. Geological Survey, Flagstaff, Ariz.), Robert E. Schlier, Joseph A. Hull, and Glenn Larson (Avco Corp., Research and Advanced Development Div., Wilmington, Mass.).
Icarus, vol. 6, May 1967, p. 315-347. 12 refs.

Proposal of a means of obtaining the ground control upon which the Lunar Orbiter photogrammetry must be based so that Apollo landing sites may be selected. A technique of combining Goldstone tracking data to show where the resulting lunar figure is positioned relative to the moon's center of mass is presented. As far as the measurement of control points is concerned, the use of corner reflectors to be placed on the lunar surface, as suggested earlier, is not essential for the success of this project. Questions regarding the influence of the frozen tide, isostasy, and past impacts of large asteroids on the present shape of the moon appear in large part answerable through data obtainable under the present theory. P.v.T.

A67-31032
INTERFEROMETRIC INVESTIGATION OF THE WAVEFRONT OF LASER BEAMS.
L. W. Davis (California, University, Dept. of Electrical Engineering and Computer Sciences, Electronics Research Laboratory, Berkeley, Calif.).
Applied Physics Letters, vol. 10, June 1, 1967, p. 301-303.
Navy-USAF-supported research.

A simple interferometric technique which uses a diverging spherical comparison wave for study of laser beams is described. The interference pattern resulting from superposition of the primary beam and a small portion of the expanded comparison wavefront provides information about both the phase and some spatial coherence properties of the primary radiation. Expected interference patterns have been obtained for a spatially coherent beam from a He-Ne gas laser. The phase character and spatial coherence features of the beam from a Q-switched ruby laser have been investigated. (Author)

A67-31033
SATURATED NEON ABSORPTION INSIDE A 6328-Å LASER.
Paul H. Lee and Michael L. Skolnick (Perkin-Elmer Corp., Norwalk, Conn.).
Applied Physics Letters, vol. 10, June 1, 1967, p. 303-307. 5 refs.

Description of an experiment in which excited ^{20}Ne at 0.1 torr was placed inside the cavity of a single-frequency, 6328-Å laser. A pronounced peak appeared in the output power, caused by an inverted Lamb dip effect. Because of the low pressure used, this peak was only 30 ± 5 MHz wide and must be very near the atomic resonant frequency. In contrast, the overall output curve was blue-shifted 60 ± 10 MHz by the 3-torr nominal pressure in the laser gain tube. This saturated absorption effect can be used as an absolute reference for frequency stabilization of He-Ne and similar lasers. P.v.T.

A67-31038 #
INTERACTION OF OSCILLATION MODES IN A GAS LASER WITH A SPHERICAL-MIRROR RESONATOR CAVITY [VZAIMODEISTVIE TIPOV KOLEBANII V GAZOVOM OPTICHESKOM KVANTOVOM GENERATORE S REZONATOROM SO SFERICHESKIMI ZERKALAMI].
I. M. Belousova, G. N. Vinokurov, O. B. Danilov, and N. N. Rozanov (Gosudarstvennyi Opticheskii Institut, Leningrad, USSR).
Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, May 1967, p. 1146-1156. 8 refs. In Russian.

Experimental and theoretical investigation of the interaction of nonaxial modes of oscillation in a He-Ne laser with a spherical-mirror resonator cavity. The resonator cavity is of the type having an equivalent confocal cavity. It is found that a laser using such a resonator cavity operates at oscillation modes with high transverse indices, and that oscillations at frequencies below 20 kc are absent. An analysis of the interaction of oscillations with similar resonator frequencies reveals the presence of a region characterized by forcing of the oscillations, the width of which agrees with the experiment. V. P.

A67-31055
NOISE PROPERTIES OF MICROWAVE MASER OSCILLATORS.
S. Dmitrevsky (Harvard University, Div. of Engineering and Applied Physics, Cambridge, Mass.).
Physical Review, 2nd Series, vol. 157, May 10, 1967, p. 196-203. 6 refs.
Contract No. Nonr-1866(16).

The properties of the power spectrum of the output noise of an X-band ruby maser oscillator were observed for a range of circuit parameters and temperatures. The peaked shape and magnitude were explained in terms of a shot-noise theory developed by McCumber for maser oscillators. The experiments confirmed the theoretical dependence of the frequency of the noise spectrum peak on the stored electromagnetic energy and cavity losses. Noise contributions due to different loss mechanisms were analyzed by varying the temperature of appropriate circuit portions. A discrepancy was established between the observed transient behavior of the maser oscillator and theoretical predictions based on rate equations. (Author)

A67-31067 #
THE "LASER-LIKE" NATURE OF TYPE I SOLAR RADIO BURSTS.
E. I. Mogilevskii (Akademiia Nauk SSSR, Institut Zemnogo Magnetizma, Ionosfery i Rasprostraneniia Radiovoln, Krasnaya Pakhra, USSR).
(Geomagnetizm i Aeronomiia, vol. 6, Sept.-Oct. 1966, p. 809-814.)
Geomagnetism and Aeronomy, vol. 6, no. 5, 1966, p. 625-628. 15 refs. Translation.

A67-31195
APPLIED LASERS.
James Vollmer (Radio Corporation of America New York, N.Y.).
IEEE Spectrum, vol. 4, June 1967, p. 66-70. 9 refs.

Two short-distance voice-communication systems using lasers are described - one requiring careful boresight alignment and the other involving a megaphone-like broad-beam laser that needs little alignment. A laser range-measuring system has been developed that can make distance checks for aircraft refueling or for measuring the altitude of spacecraft landing on the moon. The principles of ranging can also be applied to selective viewing, maintaining a separation of vehicles moving along a set path, or selectively counting certain-sized objects. The laser also can be used in a simple intrusion alarm since its narrow beam can be reflected over a very long distance with little spreading. (Author)

A67-31396 #
A TÖPLER APPARATUS WITH A PULSED RUBY LASER FOR OBSERVING A PLASMA CLOUD [TEPLEROVSKAIA USTANOVKA S IMPUL'SNYM RUBINOVYM LAZEROM DLIA ISSLEDOVANIIA PLAZMENNOI OBOLOCHKI].
V. P. Vinogradov, L. G. Golubchikov, N. V. Filippov, and T. I. Filippova (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR).
Teplofizika Vysokikh Temperatur, vol. 5, Mar.-Apr. 1967, p. 343-348. In Russian.

Description of an experimental arrangement for optical observation of rapidly moving plasma clouds by taking instantaneous photographs of discharges in transmitted laser light. The Töpler apparatus and the discharge chamber is described in detail. The pulsed ruby laser had a power of 2 mw and a pulse duration of ~ 40 nsec. A series of photographs was taken during discharges in hydrogen at 2 mm Hg pressure and 8 kv voltage. Since only one photograph was possible for each discharge, the photographs were taken at different periods following each discharge, with equal conditions being maintained during each discharge. The resulting photographs depict the systematic movement of a plasma cloud during pulsed discharges in rarefied gases. These photographs give rise to certain conclusions regarding the form and structure of plasma clouds at a given moment of the discharge formation. T.M.

A67-31484 #
QUASI-CONTINUOUS CaF_2-Dy^{2+} LASER WITH PYROTECHNIC EXCITATION [KVAZINEPRERYVNYI OPTICHESKII KVANTOVYI GENERATOR NA OSNOVE CaF_2-Dy^{2+} S PIROTEKHNICHESKIM VOZBUZHDENIEM].
A. I. Bodretsova, A. A. Kaminskii, S. I. Levikov, and V. V. Osiko (Akademiia Nauk SSSR, Institut Kristallografii, Moscow, USSR).
Akademiia Nauk SSSR, Doklady, vol. 174, May 11, 1967, p. 337, 338. 5 refs. In Russian.

Discussion of experiments in which a CaF_2-Dy^{2+} laser was pumped by four pyrotechnic lamps with a charge of ~ 600 mg each. It proved possible to obtain an output power of ~ 4 joules and a pulse duration of ~ 50 msec. This pulse duration is seen to be an indication that the laser operates in a quasi-continuous mode. It is found that the output power can be increased by increasing the concentration of Dy^{2+} in the crystal and by proper selection of mirror transmission. V.P.

A67-31562
THEORY OF COUPLED MODE OSCILLATION IN A LASER WITH AXIAL MAGNETIC FIELD.
H. Pelikan (Stuttgart, Technische Hochschule, II. Institut für theoretische Physik, Stuttgart, West Germany).
Zeitschrift für Physik, vol. 201, no. 5, 1967, p. 523-535. 8 refs.

The nonlinear laser theory without noise is applied to calculate amplitudes, frequencies and beat frequencies of two circularly polarized modes in a laser with axial magnetic field. The resonator is allowed to have different damping constants for waves polarized in x- and y-direction. For small beat frequencies frequency locking occurs, and the modes combine to a linearly or elliptically polarized mode. The plane of polarization rotates with increasing magnetic field up to $\pm\pi/4$. (Author)

A67-31576
APPLICATION OF HIGHLY IONIZED PLASMA TO LASER CONSTRUCTION.
L. I. Gudzenko, V. N. Kolesnikov, N. N. Sobolev, and L. A. Shelepin.
(Magnitnaia Gidrodinamika, vol. 1, July-Sept. 1965, p. 54-56.)
Magnetohydrodynamics, vol. 1, July-Sept. 1965, p. 39, 40. 5 refs. Translation.

Discussion of the application of MHD energy converters based on nonequilibrium plasmas to the generation of lasers. The possibility of developing a laser based on a highly ionized low-temperature plasma is considered. It is concluded that the use of various MHD cooling methods may be of considerable interest in solving the problem of creating an amplifying medium based on a low-temperature highly ionized plasma. M.F.

A67-31741
ULTRASHORT LIGHT PULSES.
A. J. DeMaria, D. A. Stetser, and W. H. Glenn, Jr. (United Aircraft Corp., United Aircraft Research Laboratories, East Hartford, Conn.).
Science, vol. 156, June 23, 1967, p. 1557-1568. 38 refs.
Army-USAF-supported research.

Survey of recent efforts to generate optical pulses of extremely high peak power (approximately 10^{10} watts) and extremely short duration (of the order of 10^{-13} sec). The method of generating ultrashort laser pulses is described in terms of the operation of lasers in the mode-locked or phase-locked condition. Methods of Q-switching are analyzed, and experiments performed with ultrashort pulse lasers during simultaneous Q-switching and phase-locking are reviewed. Direct measurements of the duration of optical pulses, made by displaying on an oscilloscope the output of a suitable photodetector illuminated by the optical radiation, are examined. Methods of generating single ultrashort laser pulses are studied, and the experimental arrangements are described. T.M.

A67-31798 #

PERFORMANCE OF AN AIRBORNE LASER PROFILER.

Homer Jensen (Litton Industries, Inc., Aero Service Corp., Philadelphia, Pa.).

IN: AIRBORNE PHOTO-OPTICAL INSTRUMENTATION; PROCEEDINGS OF A SEMINAR-IN-DEPTH, COCOA BEACH, FLA., FEBRUARY 20, 21, 1967. [A67-31791 16-14]

Seminar sponsored by the Society of Photo-Optical Instrumentation Engineers, the American Society of Photogrammetry, and the U.S. Air Force Eastern Test Range.

Redondo Beach, Calif., Society of Photo-Optical Instrumentation Engineers, 1967, p. VIII-1 to VIII-6.

Discussion of an airborne laser profiler, which provides a detailed, exact, and continuous measurement of ground profiles from a high speed aircraft. CW and pulsed lasers are considered for their range-finding ability in a system in which the phases of transmitted and received laser energy are compared and expressed in terms of distance. To complete the facility, a bore-sighted, continuous-strip, 35-mm camera is used to record the flight path. B.B.

A67-31808

LASER MODE-LOCKING WITH SATURABLE ABSORBERS.

Elsa M. Garmire and Amnon Yariv (California Institute of Technology, Dept. of Electrical Engineering, Pasadena, Calif.).

IEEE Journal of Quantum Electronics, vol. QE-3, June 1967, p. 222-226. 13 refs.

Contract No. AF 33(615)-67C-1055.

Description of a mode-locked laser in terms of traveling pulses of light. It is indicated that the energy absorbed by a saturable absorber is at a minimum if the pulse length is at a minimum and that two pulses are essentially as favorable as one, if they meet at the position of the dye cell. Under steady-state pulsing conditions, however, the pulses have a width which depends on their energy. Finally, it is demonstrated that a linearly dispersive medium does not broaden the mode-locked laser pulses to first order. B.B.

A67-31879

MEASUREMENTS OF LASER-BEAM SCINTILLATION IN THE ATMOSPHERE.

D. L. Fried, G. E. Mevers, and M. P. Keister, Jr. (North American Aviation, Inc., Autonetics Div., Electro-Optical Laboratory, Anaheim, Calif.).

Optical Society of America, Journal, vol. 57, June 1967, p. 787-797. 17 refs.

Measurements have been made of the scintillation of a laser beam after propagating over an 8-km path near the ground. The measurements were made with collection apertures ranging from 1 mm to 1 m in diameter. The probability distribution of the scintillation was found to be log-normal for all collector diameters. The log-normal variance decreased smoothly for diameters from 1 mm to about 10 cm, but showed no decrease between 10 cm and 1 m. A hypothesis is offered which explains those results which are anomalous in terms of present theories. Measurements of the log-normal variance were made over extensive periods on three days, during winter, spring, and summer. From these the atmosphere's refractive-index structure constant, C_N^2, was computed. Values of C_N^2 were found to be fairly constant over the full range of measurements, falling between 3 and 6 x 10^{-15} $m^{-2/3}$, except near sunrise and sunset, when values of about 1 x 10^{-15} $m^{-2/3}$ were more typical. (Author)

A67-31882 #

SPECKLE PATTERN FORMED BY LASER SCATTERING FROM PARTICLES IN GASES.

Sherman Gee (ARO, Inc., Arnold Engineering Development Center, Arnold Air Force Station, Tenn.).

Optical Society of America, Journal, vol. 57, June 1967, p. 836, 837.

Application of the results obtained by Goldfischer concerning the spatial autocorrelation function and power spectral density of the speckle pattern produced by laser scattering from a diffuse surface to the case of laser scattering from particles in a gas. It is shown that the autocorrelation function of the speckle pattern formed by laser scattering from particles in a gas and from a diffuse surface will be the same under fairly general conditions. However, the intensity of the speckle pattern formed in the two cases will most likely be quite different, depending on the comparative scattering cross sections of the diffuse surface and the particles in the gas. M.F.

A67-31926 #

CALCULATION OF THE OUTPUT POWER OF A GAS LASER [RASCHET VYKHODNOI MOSHCHNOSTI GAZOVOGO LAZERA].

A. G. Velichko (Saratovskii Gosudarstvennyi Universitet, Saratov, USSR).

Fizika, vol. 10, no. 5, 1967, p. 94-98. 12 refs. In Russian.

Analysis of a general expression previously derived for the amplification factor of a gas laser, in the limiting case where the number of axial-oscillation modes is infinitely large under operating conditions. The output power is calculated as a function of resonator length and pumping power. A comparison between theory and experiment leads to values for the dispersion width of the Ne-1.15 μ line at various pressures and for the Weisskopf radius for collisions with neutral He atoms. V.P.

A67-32232

NEWS ABOUT THE DIADEME 1 AND 2 SATELLITES [NOUVELLES DES SATELLITES DIADEME I ET II].

J.-P. Causse, Galabert, R. Chevalier (Centre National d'Etudes Spatiales, Paris, France), and W. von Braun.

La Recherche Spatiale, vol. 6, May 1967, p. 11. In French.

Discussion of the present state of operation of the Diademe 1 and 2 satellites. On Apr. 5, 1967, the Diademe 2 satellite suddenly stopped transmitting; the cause of this malfunction is thought to be a failure of the power supply system. It is pointed out that the stabilization system of the satellite, consisting of permanent magnets and magnetically permeable rods, is totally independent of the power supply system and that the laser experiments planned remain feasible. Both Diademe 1 and Diademe 2 are used for space geodetic research purposes. The Diademe 1 satellite is functioning normally. M.F.

A67-32237

AN OPTICAL COMMUNICATION LINK FOR LABORATORY DEMONSTRATION USING MICROWAVE MODULATION OF THE LIGHT BEAM.

B. Trevelyan (Elliott Brothers /London/, Ltd., Frimley, Surrey, England) and H. Pursey (National Physical Laboratory, Div. of Molecular Science, Teddington, Middx., England).

Radio and Electronic Engineer, vol. 33, June 1967, p. 384-386. 7 refs.

Evaluation of a simple system designed to demonstrate the possibility of information transmission over an optical path, using a microwave subcarrier. It is indicated that a satisfactory SNR can easily be obtained under laboratory conditions. The practical limitations of the proposed system are outlined. The overall SNR is found to be better than 20 db with a modulation index of 0.05 and a path-length of a few meters. B.B.

A67-32274 #

COOPERATIVE LIGHT SCATTERING FROM THETA-PINCH PLASMAS.

M. Daehler and F. L. Ribe (California, University, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.).

Physics Letters, vol. 24A, June 19, 1967, p. 745, 746. 12 refs.

AEC-sponsored research.

Measurement of the scattering of ruby-laser light at 6.25° by a 150-kjoule ϑ-pinch plasma with a two-etalon Fabry-Pérot spectrometer. The spectrum shows an intense, narrow central peak, with broad wings whose width and magnitude correspond to the theoretically expected thermal feature. The narrow central component is interpreted as a consequence of cooperative density fluctuations superimposed on the thermal density fluctuations. P.v.T.

A67-32275 #
FLAME PUMPING AND INFRARED MASER ACTION IN CO_2.
I. Wieder (Carver Corp., Mountain View, Calif.).
Physics Letters, vol. 24A, June 19, 1967, p. 759, 760. 11 refs.
Research supported by the Mobil Oil Co. and the Carver Corp.

Observation of continuous infrared maser action in CO_2 excited by purely chemical means. The method employed, which is called chemi-optical resonant pumping, utilizes resonance radiation from molecules formed by combustion to excite other molecules isolated from the reaction. The method of chemi-optical resonant pumping is also applicable to explosions, in which case considerably higher output-power pulses can be expected. The method should ultimately be applicable to many different molecules and a wide variety of fuels. It may also be possible to utilize isotope shifts to improve the match between source radiation and absorber molecules. P.v.T.

A67-32277 #
INTERFERENCE EFFECTS AT THE SINGLE PHOTON LEVEL.
R. L. Pfleegor and L. Mandel (Rochester, University, Dept. of Physics and Astronomy, Rochester, N.Y.).
Physics Letters, vol. 24A, June 19, 1967, p. 766, 767. 6 refs.
USAF-supported research.

Demonstration of interference effects in the superposition of two light beams from two independent lasers under conditions where the intensity was so low that one photon was absorbed, with high probability, before the next one was emitted by either one of the sources. Despite the rather low statistical accuracy of the results, there is good evidence for the existence of interference fringes, under conditions where there is a negligible probability of an interaction between two or more photons within the apparatus. P.v.T.

A67-32293
MEASUREMENT OF THE EFFECTIVE CROSS SECTION OF STIMULATED EMISSION OF NEODYMIUM AT 1.06 μ [MESURE DE LA SECTION EFFICACE D'EMISSION STIMULEE DU NEODYME A 1,06 μ].
Jean-Michel Jego (Commissariat à l'Energie Atomique, Centre d'Etudes de Limeil, Service Documentation, Villeneuve-Saint-Georges Seine-et-Oise, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 22, May 29, 1967, p. 1496-1498.
5 refs. In French.

Direct measurement of the effective cross section of stimulated emission by studying a Q-switched laser pulse produced by using a neodymium-glass bar as the crystal. The losses due to the mirrors are quite substantial under the conditions of the experiment. It is pointed out that the method used should make it possible, by selecting the cavity modes, to plot the profile of the fluorescence band during the laser emission. M.F.

A67-32305
DEPENDENCE OF THE PROPAGATION LOSS IN LASER RANGING SYSTEMS ON THE METEOROLOGICAL VISIBILITY AND TARGET/RECEIVER RANGE.
W. M. Nixon, J. L. Clarke, and J. E. Copeland (Ministry of Technology, Royal Radar Establishment, Great Malvern, Worcs., England).
Electronics Letters, vol. 3, June 1967, p. 246, 247.

The relationship between meteorological visual range and the propagation loss in laser beams has been studied at wavelengths of 0.6943 and 1.065 μ. For visual ranges of 1 to 10 km, the laser propagation loss is found to be compatible with that predicted by existing equations relating extinction coefficient to visual range and wavelength. The inverse-square law relating received signal strength to target/receiver range is confirmed. (Author)

A67-32316
DELAY TIME BETWEEN THE CURRENT PULSE AND THE LIGHT EMISSION OF GaAs LASER DIODES.
G. Guekos and M. J. O. Strutt (Swiss Federal Institute of Technology, Dept. of Advanced Electrical Engineering, Zurich, Switzerland).
Electronics Letters, vol. 3, June 1967, p. 276, 277. 5 refs.

The delay time t_d between the onset of the current pulse and that of the light emission has been measured above threshold as a function of the diode current I for several GaAs laser diodes at a temperature of about 77°K. When plotted against $\ln [I/(I - I_{th})]$, t_d decreases with increasing current, but does not obey the linear relation found by others. The values of t_d measured near threshold are in satisfactory agreement with the spontaneous emission time calculated from theory. Although the measured curves are all of the same shape, differences of t_d exist among the diodes, which are supposed to be caused by the presence of traps. (Author)

A67-32362
THE PROBLEM OF REGULAR RELAXATION PULSES OF CRYSTAL LASERS [ZUM PROBLEM DER REGELMÄSSIGEN RELAXATIONSIMPULSE VON KRISTALLASERN].
Dieter Rõss (Siemens AG, Zentral-Laboratorium für Nachrichtentechnik, Munich, West Germany).
Zeitschrift für Naturforschung, Ausgabe A, vol. 22a, May 1967, p. 822-827. 23 refs. In German.

Study of the effects of diffraction loss and mode-stability time on the behavior of curved resonators and demonstration that this modified behavior can hinder the construction of discrete transverse modes during pulsed operation of crystal lasers. The observed emission corresponds to a continuum of nonresolved transverse modes. Under the assumption of finite, but large diffraction loss, criteria are given for regular relaxation oscillations; it is shown that the criteria are realized only in the region of stable boundary positions. Thermal-resonance drift is shown to be responsible for the appearance of undamped, periodic relaxation pulses; spontaneous emission, on the other hand, causes a damping effect at high mode numbers. R.B.S.

A67-32366 #
THE USE OF GAS LASERS [POUŽITÍ PLYNOVÝCH LASERŮ].
Z. Veselá (Československá Akademie Věd, Ústav Přístrojové Techniky, Brno, Czechoslovakia).
Jemná Mechanika a Optika, vol. 12, June 1967, p. 179-183. In Czech.

Survey of gas-laser applications in the fields of construction, mechanics, communications, biology, and medicine. In the area of mechanics and construction, the use of lasers for control of the precise position of a plane or an axis is described. Equipment which is discussed includes lasers utilized in the building of tall structures, tunnels, navigation, calibration, surface-smoothness control, velocity measurements, deformation measurements, and metal processing. Lasers in communications technology are reviewed in terms of recent experiments with signal-transmission and television systems, lasers as sources of electromagnetic waves for highly complex antenna models, and optical radar systems. Applications in biology and medicine are discussed and the principles of microholography are described. T.M.

A67-32368
OBSERVATION OF PLASMA ION OSCILLATIONS IN A LASER-PRODUCED PLASMA.
Hugo Weichel, P. V. Avizonis, and D. F. Vonderhaar (USAF, Systems Command, Research and Technology Div., Weapons Laboratory, Kirtland AFB, N. Mex.).
Physical Review Letters, vol. 19, July 3, 1967, p. 10-12. 9 refs.
ARPA-supported research.

Discussion of experiments with 6943-Å light scattered from a high-density carbon plasma which resulted in the spectroscopic observation of ion wings produced by plasma-ion oscillations. For an energy density of 200 joules/cm^2 and a pulse half-width of 90 nsec, the maximum separation of the ion wings was found to be 0.9 Å. This corresponds to a plasma-electron temperature of more than 25 ev and a density of 10^{19} electrons/cm^3. M.F.

A67-32374
RADIATION EFFECTS IN GLASS LASERS.
F. Tittel and N. Kamel (American University at Cairo, Cairo, Egypt).
IN: INTERACTION OF RADIATION WITH SOLIDS; PROCEEDINGS OF THE CAIRO SOLID STATE CONFERENCE, AMERICAN UNIVERSITY AT CAIRO, CAIRO, EGYPT, SEPTEMBER 3-8, 1966. [A67-32371 17-26]
Edited by Adli Bishay.
New York, Plenum Press, Division of Plenum Publishing Corp., 1967, p. 261-271; Discussion, E. Deeg, Mostafa El Azab (American University at Cairo, Cairo, Egypt), and R. Woodstock (American Optical Co., Research Div., Southbridge, Mass.), p. 271, 272.
10 refs.

Experiments are in progress to study the effects of gamma ray irradiation on the stimulated emission properties of laser glasses. The effects of high energy radiation upon glass are complex. The two principal processes are ionization (leading to color or defect center formation) and displacement of atoms from their position in the lattice. Of particular interest are induced optical absorption effects in commercially available laser glasses of different composition and dopant ions, starting with neodymium-doped silicate glass. Such changes as light absorption in glass produced by ionizing radiation may improve the optical efficiency for a laser by increased effective coupling between an optical pump source and the active medium. Improved laser efficiency was reported for irradiated crystal systems. However, a degradation of laser performance may also occur depending on the glass network and modifier composition, especially when metallic ion impurities (lead, iron, zinc) are present. The effect of dose rate, total dose, selective bleaching and temperature are related to optical absorption and emission measurements, laser tests, optical quality and magnetic resonance studies. Comparison against both a nonirradiated and an undoped laser glass sample are made. (Author)

A67-32402
REGULAR AND IRREGULAR SPIKING OF A RUBY LASER [REGELMÄSSIGES UND UNREGELMÄSSIGES SPIKEN DES RUBINLASERS].
H. Laig-Hörstebrock and H. Weber (Berlin, Technische Universität, I. Physikalisches Institut, Berlin, West Germany).
Zeitschrift für angewandte Physik, vol. 23, no. 1, 1967, p. 1-7.
19 refs. In German.

Investigation of the temporal and spectral behavior and the mode structure of a confocal ruby laser. The number and order of oscillating modes can be varied by the mirror diameter. The relation between the mode number and the regularity of the spiking is examined. It is shown that the spiking of the output intensity becomes regular if only one mode or a great number of modes is oscillating. The thermal influence of the spectrum of the output is investigated. The experiments prove that the continuous spectrum of a confocal multimode ruby is due to inhomogeneous heating of the crystal, which causes a considerable change of mirror curvature. The modes are then no longer degenerated. In the case of one oscillating mode, frequency-hopping, due to spatial hole-burning, is observed.
P.v.T.

A67-32437
SAFER PYROTECHNICS THROUGH LASER ACTUATION.
Donald G. Lewis (Space Ordnance Systems, Inc., El Segundo, Calif.).
Space/Aeronautics, vol. 47, June 1967, p. 107, 108, 110, 111.

Evaluation of a laser-energized explosive device (LEED), which uses laser light to actuate pyrotechnic devices. The essential elements of this facility are a power source, a ruby or neodymium laser, a nonmetallic fiber-optic conductor for transmission of the laser light, and a simple initiator, detonator, or igniter. In the near future, this system is expected to be applied to an advanced missile design.
B.B.

A67-32452
LEVEL POPULATION IN PULSED ARGON-ION LASER.
V. K. Glazunov, V. F. Kitaeva, L. Ia. Ostrovskaia, and N. N. Sobolev (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, Apr. 15, 1967, p. 265-269.)
JETP Letters, vol. 5, Apr. 15, 1967, p. 215-218. Translation.

Use of the dependence of the line width on the optical thickness of the emitting layer to determine the difference in level population in the plasma of a pulse gas discharge used to obtain generation at the argon-ion lines. The experimental setup consisted of a glass tube with windows inclined at the Brewster angle. In most experiments the discharge tube was filled with a mixture of Ar and He. Many experiments were made with pure Ar.
F.R.L.

A67-32470 #
ELECTRON BEAM AND LASER BEAM LINE-SCAN RECORDING - A CRITIQUE.
Stanley J. Rostocki (USAF, Systems Command, Research and Technology Div., Avionics Laboratory, Wright-Patterson AFB, Ohio).
IN: NAECON '67; PROCEEDINGS OF THE NINETEENTH ANNUAL NATIONAL AEROSPACE ELECTRONICS CONFERENCE, DAYTON, OHIO, MAY 15-17, 1967, TECHNICAL PAPERS. [A67-32467 17-14]
Conference sponsored by the Dayton Section, and the Aerospace and Electronic Systems Group of the Institute of Electrical and Electronics Engineers.
Dayton, Ohio, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 33-38. 17 refs.

Discussion of the principal problems associated with electron-beam recorders (EBRs) and the techniques used in their application, in comparison with laser-beam recorder (LBR) techniques. Both techniques share many advantages, but neither has reached a terminal state of development. It is apparent, however, that LBRs must wait several years for the development of modulators and scanners which can compete with the proven simplicity, low cost, and efficiency of EBRs. Besides, EBRs are now so highly advanced that a relatively small investment should yield manifold results. EBRs and LBRs are complementary, not competitive. The most successful applications of these techniques will be those which give full consideration to mating the technology to the application.
P.v.T.

A67-32482 #
A NANOSECOND LASER SENSITOMETER.
David Power (USAF, Systems Command, Research and Technology Div., Avionics Laboratory, Wright-Patterson AFB, Ohio) and R. Michael Hord (Technology, Inc., Dayton, Ohio).
IN: NAECON '67; PROCEEDINGS OF THE NINETEENTH ANNUAL NATIONAL AEROSPACE ELECTRONICS CONFERENCE, DAYTON, OHIO, MAY 15-17, 1967, TECHNICAL PAPERS. [A67-32467 17-14]
Conference sponsored by the Dayton Section, and the Aerospace and Electronic Systems Group of the Institute of Electrical and Electronics Engineers.
Dayton, Ohio, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 117-120.

Description of a rastering nanosecond laser sensitometer, which is required to evaluate materials responsive to signals of such short duration and thus make nanosecond recording feasible. The principles of recording and sensitometry are discussed in order to define the necessary functions of the sensitometer. The design requires the use of a wide range of techniques for controlling and measuring both the quantity and quality of light used for exposure, as well as the duration of the exposure. A variety of light sources may be used. The optical system, the photomultiplier subsystem, and the method of rastering are described.
F.R.L.

A67-32483 #
GaAs LASER REFLECTANCE MEASUREMENTS OF TACTICAL LANDING TERRAIN SAMPLES.

Dittmar Kittler (USAF, Air University, Institute of Technology, Wright-Patterson AFB, Ohio) and Paul Polishuk (USAF, Systems Command, Research and Technology Div., Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio).
IN: NAECON '67; PROCEEDINGS OF THE NINETEENTH ANNUAL NATIONAL AEROSPACE ELECTRONICS CONFERENCE, DAYTON, OHIO, MAY 15-17, 1967, TECHNICAL PAPERS. [A67-32467 17-14] Conference sponsored by the Dayton Section, and the Aerospace and Electronic Systems Group of the Institute of Electrical and Electronics Engineers.
Dayton, Ohio, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 121-127.

Experimental measurement study performed as a result of an investigation of the tactical landing problem. Based on this study, it was found that the characteristics of GaAs lasers made them well suited for tactical landing aids. Applying a GaAs pulsed laser as an air-to-ground ranging device introduced the need for experimental data on reflection coefficients of various landing terrain media. Reflection coefficients were measured in the laboratory under simulated air-to-ground ranging conditions. F.R.L.

A67-32495 #
DESIGN CONSIDERATIONS OF MULTIPLE LASER COMMUNICATION LINKS BETWEEN A SYNCHRONOUS SATELLITE AND SEVERAL EARTH STATIONS.
N. C. Chang and E. G. Brock (Aerospace Corp., El Segundo, Calif.).
IN: NAECON '67; PROCEEDINGS OF THE NINETEENTH ANNUAL NATIONAL AEROSPACE ELECTRONICS CONFERENCE, DAYTON, OHIO, MAY 15-17, 1967, TECHNICAL PAPERS. [A67-32467 17-14] Conference sponsored by the Dayton Section, and the Aerospace and Electronic Systems Group of the Institute of Electrical and Electronics Engineers.
Dayton, Ohio, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 197-200. 11 refs.
Contract No. AF 04(695)-1001.

Description of a design approach for using a single telescope and a single laser aboard an earth-synchronous satellite to provide a number of two-way links between the satellite and a number of ground stations. It is noted that a great deal of analysis and experimental work is needed to evaluate the concept. It is shown that for the proposed system a high degree of privacy in communication is possible and that an information rate of megabits per second is achievable. Regarding communication between ground stations through the satellite, it is pointed out that this can be done with a man aboard the satellite or with remote switch systems. M.M.

A67-32611
FREQUENCY STABILIZATION OF GAS LASERS.
George Birnbaum (North American Aviation, Inc., Science Center, Spectroscopy Group, Thousand Oaks, Calif.).
(International Scientific Radio Union, General Assembly, 15th, Munich, West Germany, Sept. 5-19, 1966, Paper.)
IEEE, Proceedings, vol. 55, June 1967, p. 1015-1026. 65 refs.

Methods of frequency and wavelength stabilization of gas lasers are reviewed with emphasis on principles of operation and results of stability measurements rather than experimental details or apparatus design. Most of the stabilization work has been done with the He-Ne laser. The best long-term stability is about 1 part in 10^9. Various absolute wavelength measurements of stabilized He-Ne lasers by interferometric comparison with standard lamps give agreement to about 2 parts in 10^7. Wavelength shifts due to variations of gas pressure and gain are important factors in limiting the absolute wavelength stability of gas lasers. Optical standards of length and their use in length measurements are considered. (Author)

A67-32612
MEASUREMENT OF LASER ENERGY AND POWER.
George Birnbaum (North American Aviation, Inc., Science Center, Spectroscopy Group, Thousand Oaks, Calif.) and Milton Birnbaum (Aerospace Corp., Resonance Phenomena Section, El Segundo, Calif.).
(International Scientific Radio Union, General Assembly, 15th, Munich, West Germany, Sept. 5-19, 1966, Paper.)
IEEE, Proceedings, vol. 55, June 1967, p. 1026-1031. 36 refs.

Measurements of laser energy and power are discussed with emphasis on those methods which attempt to establish the accuracy or standards for such measurements. Devices to attenuate laser radiation are summarized. The principles and limitations of the methods are stressed rather than design details of the apparatus. It is found that standards for the measurement of laser power and energy are yet to be definitely established. Thus caution should be exercised in accepting stated accuracies for laser output measurements. (Author)

A67-32613
LASER MEASUREMENTS OF LONG DISTANCES.
P. L. Bender (National Bureau of Standards and Colorado, University, Joint Institute for Laboratory Astrophysics, Boulder, Colo.).
IEEE, Proceedings, vol. 55, June 1967, p. 1039-1045. 63 refs.

Discussion of various types of new measurements which have been made possible by the extension of rf techniques to the optical region of the spectrum. One area in which important scientific contributions can be expected during the next few years is the use of lasers to measure long distances with high accuracy. Three types of distance measurements which have been discussed in the literature and which are now being investigated actively are: (1) interferometric measurements over distances of up to hundreds of meters through evacuated or sealed-off tubes, (2) measurements with modulated laser beams over distances of perhaps one to fifty kilometers with corrections made for the atmospheric index of refraction along the path, and (3) range measurements to artificial satellites and to the moon using laser radar. Some of the possible geophysical and geodetic applications of such measurements are discussed. M.M.

A67-32661
STUDY OF A COMPOUND-CAVITY LASER.
M. P. Vaniukov, V. I. Isaenko, V. P. Kalinin, and V. V. Liubimov.
(Optika i Spektroskopiia, vol. 22, Mar. 1967, p. 462-467.)
Optics and Spectroscopy, vol. 22, Mar. 1967, p. 249-252. Translation.

Demonstration that the radiations emerging from the two optically coupled cavities of a compound laser can be identical in time and in spectral composition without tuning one cavity to the other. It is pointed out that the identity of the radiation spectra of two lasers which have different characteristic-frequency spectra and different vibrational modes can be achieved, because the two cavities excite induced oscillations in each other. M.M.

A67-32662
SOME CHARACTERISTICS OF A He-Ne LASER GENERATING SIMULTANEOUSLY AT 3.39 AND 0.6328 μ.
Iu. M. Golubev and V. E. Privalov.
(Optika i Spektroskopiia, vol. 22, Mar. 1967, p. 499-501.)
Optics and Spectroscopy, vol. 22, Mar. 1967, p. 271. Translation.

Measurements of the characteristics of a He-Ne laser mixture carried out with one tube with a length of 1 m and an interval diameter of 6 mm, when the two lines 3.392 and 0.6328 μ were simultaneously generated. The dependence of the simultaneous generation of the two lines on pressure was found to be of interest. The variation of the output power with discharge current for different discharge lengths with a total pressure of 2 torr and a He-Ne ratio of 9:1 is shown, together with the variation of the output radiation with discharge current for two pressures. M.M.

A67-32663
RADIATION KINETICS OF A LASER WITH A LENS SYSTEM AND A LOW-ABSORPTION NONLINEAR MEDIUM IN THE RESONATOR.

E. G. Berzing, Iu. V. Naboikin, I. A. Rom-Krichevskaia, and Iu. A. Tiunov.
(Optika i Spektroskopiia, vol. 22, Mar. 1967, p. 503-505.)
Optics and Spectroscopy, vol. 22, Mar. 1967, p. 274, 275. 6 refs. Translation.

Measurement of radiation kinetics in a laser with a resonator having a system of lenses which emits regular damped oscillations. Preliminary analytical results obtained showed that the effect of the weakly absorbing lenses on the operation of the laser involves a shift in time of the kinetic curves which characterize the population of the working level and the energy density in the resonator. M.M.

A67-32667 #
EXCITATION OF FABRY-PEROT RESONATOR. I.
Hisanao Ogura, Yasuo Yoshida, and Iwao Iwamoto (Kyoto University, Dept. of Electronics, Kyoto, Japan).
Physical Society of Japan, Journal, vol. 22, June 1967, p. 1421-1433. 9 refs.

This paper deals with a Fabry-Pérot resonator formed by parallel circular plate mirrors. The method of formulation consists in setting up a set of simultaneous integral equations which represent continuities of the field and of its normal gradient across the open wall. The integral equations are transformed into a set of inhomogeneous linear equations for the components of the two infinite-dimensional vectors corresponding to the two boundary-value functions. For a simple excitation, where the driving source is uniformly distributed over a small circular area at the center of the mirror, the equations are solved by a successive-approximation method using an electronic computer. The amplitude and phase distributions of the field are obtained for several driving frequencies and Fresnel numbers. The input characteristic, which shows a series of resonances, is also given. (Author)

A67-32668 #
EXCITATION OF FABRY-PEROT RESONATOR. II.
Hisanao Ogura, Yasuo Yoshida, and Jun-Ichi Ikenoue (Kyoto University, Dept. of Electronics, Kyoto, Japan).
Physical Society of Japan, Journal, vol. 22, June 1967, p. 1434-1445. 8 refs.

Investigation of the case of free oscillations of a Fabry-Pérot resonator. The free oscillation of a Fabry-Pérot resonator is defined by a complex frequency which satisfies a determinantal equation, and the diffraction loss and the resonant frequency are obtained. The mode patterns are given for (0, 0), (1, 0), (0, 1) and (2, 0) modes with Fresnel number N = 5, 10, and 20, some of which reproduce the fine details of the patterns found by Fox and Li. The free oscillation of a deformed Fabry-Pérot resonator is investigated by an application of the theory of excitation. The diffraction loss in the presence of tilt deformation is obtained from the root of the determinantal equation, modified slightly by virtue of the deformation, and is given by a simple algebraic expression in the same form as a previously obtained result for cavity theory. (Author)

A67-32691
LASER APPLICATIONS.
Theodore H. Maiman (Korad Corp., Santa Monica, Calif.).
Physics Today, vol. 20, July 1967, p. 24-28.

Description of a wide variety of laser applications, each stemming from one or more laser characteristics. Power density and monochromaticity are exploited in studying reflectance, light scattering from plasma, Rayleigh scattering and Raman spectra, and in creating high plasma densities. Enormous spectral brightness offers advantages in the study and production of nonlinear phenomena and analysis of bodies at relatively high laboratory temperatures. Laser characteristics have also helped to create more sensitive instruments for interferometry, photography, Doppler-shift measurements, and for the new field of holography. The enormous power density that can be produced from a Q-switched, short-pulsed laser leads to several applications, among which are electrical breakdown of gases, thermionic emission, and vaporizing of materials for such fields as chemical emission spectroscopy and mass spectroscopy. P. v. T.

A67-32705
FREQUENCY VARIATION OF A Q-SWITCHED LASER BY A PHTHALOCYANINE SOLUTION [VARIATION DE FREQUENCE D'UN LASER DECLENCHE PAR UNE SOLUTION DE PHTALOCYANINE].
Alain Orszag and René Saron (Ecole Polytechnique, Laboratoire de Physique Vignal, Paris, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 23, June 5, 1967, p. 1580-1583. 7 refs. In French.

Account of the variation of the frequency of a ruby laser which is optically pumped by a flash lamp and which has two mirrors the coefficients of reflection of which are 1 and 0.86, by use of a solution of vanadium phthalocyanine in α-chloronaphthalene. In the course of the giant pulse, an augmentation of the emission wavelength was observed, the magnitude of which depended on the concentration of the solution of phthalocyanine. Two mechanisms which seem to be responsible for the effect observed are discussed. F.R.L.

A67-32726
DEVELOPMENT OF LASER GYROSCOPES IN THE U.S. [LA MISE AU POINT DES GYROMETRES A LASER AUX ETATS-UNIS].
R. Luziau.
Doc-Air-Espace, May 1967, p. 47-54. 5 refs. In French.

Discussion of laser gyroscopes as an aid to navigation and guidance. The principle of the laser gyroscope is that of a luminous path drawn into rotary motion. A laser in a ring is described. Advantages of the laser gyroscope are the absence of parasitic couples and low startup time. It resists accelerations, has high resolving power, and the range of measurement is wide. The problem of mode synchronization is discussed. Details are given of the work in progress by Sperry and Honeywell. F.R.L.

A67-32745
FRENCH RESEARCH AND DEVELOPMENT IN THE FIELD OF LASERS [RECHERCHES ET REALISATIONS FRANÇAISES DANS LE DOMAINE DU LASER].
J. Ernest (Compagnie Générale d'Electricité, Centre de Recherches, Marcoussis, Seine-et-Oise, France).
L'Onde Electrique, vol. 47, June 1967, p. 771-777. 5 refs. In French.

Description of the present state of research and development attained by French laboratories in the field of lasers. The main research and development trends of the French effort are emphasized - i.e., solid-state high-brightness lasers, molecular lasers of high CW power, and gas lasers (helium-neon, ionized argon) as tools for applications utilizing their high degree of coherence (holography, metrology, laser gyros). A list of laser activities of the main French organizations engaged in the field in 1966-1967 is included. M.F.

A67-32772 *
SELECTIVE LASER PHOTOCATALYSIS OF BROMINE REACTIONS.
W. B. Tiffany, A. L. Schawlow (Stanford University, Stanford, Calif.), and H. W. Moos (Johns Hopkins University, Baltimore, Md.).
Science, vol. 157, July 7, 1967, p. 40-43. 19 refs.
Research supported by Sylvania Electronic Systems; Grant No. NsG-331.

Study of the nature and dynamics of a gaseous chemical reaction by means of photocatalysis induced by monochromatic laser light. A frequency-tuned ruby laser with a high repetition rate was designed and constructed. Special techniques for obtaining high monochromaticity were used. The laser was used as a light source for the selective photocatalysis of gas-phase reactions between bromine and certain unsaturated fluorocarbons. This was the first reported photochemical reaction of bromine with light in the 14,400 cm^{-1} spectral region. The selective-excitation technique provides new information, which can be used to determine both the mechanism of the reaction and the rates of molecular energy transfer and which is not obtainable by other methods. M.M.

A67-32804
THEORY OF ARGON BREAKDOWN UNDER THE EFFECT OF LASER RADIATION [THEORIE DU CLAQUAGE DE L'ARGON SOUS L'EFFET DU RAYONNEMENT D'UN LASER].
F. Cernuschi, H. Girotti, L. Bassani (Buenos Aires, Universidad, Departamento de Física, Buenos Aires, Argentina), and A. Rachman (Buenos Aires, Universidad, Departamento de Física; Consejo Nacional de Investigaciones Científicas y Técnicas, Buenos Aires, Argentina).
Journal de Physique, vol. 28, May-June 1967, p. 401-405. 12 refs. In French.

Theoretical interpretation of the effect resulting in a spark when a laser beam is highly concentrated on a cell containing argon at a pressure p_a. The fundamental hypothesis consists of the assumption that the interaction between the laser beam and the gas may be macroscopically described by means of a model analogous to the one used for the study of stars in local thermodynamic equilibrium. Since the spark develops 9 nsec after the focusing of the laser, whose pulse duration is 30 nsec, it is assumed that the entire energy of the laser after 9 nsec is completely disordered and that the spark consequently radiates as a nearly black body. Assuming these conditions, the temperature distribution within the spark is calculated, using the equilibrium equations for a gaseous star. By establishing a complementary hypothesis for the breakdown condition, the laser's threshold power as a function of p_a is determined. Comparison with Minck's (1964) experimental results indicates a close approximation. T.M.

A67-32917 #
IONIZATION OF MEDIA AND PLASMA GENERATION BY LASER EMISSION [IONIZATSIIA SRED I SOZDANIE PLAZMY S POMOSHCH'IU IZLUCHENIIA LAZERA].
G. A. Askar'ian and M. S. Rabinovich.
IN: PLASMA PHYSICS [FIZIKA PLAZMY].
Edited by D. V. Skobel'tsyn.
Moscow, Izdatel'stvo Nauka (Akademiia Nauk SSSR, Fizicheskii Institut, Trudy, Volume 32), 1966, p. 89-96. 13 refs. In Russian.

Review of recent papers dealing with laser applications for medium ionization, sterile-plasma production, dense-plasma heating, and plasma-trap filling. Among the topics considered are medium-avalanche ionization by an intense light pulse, diamagnetic disturbance due to medium ionization by an intense light beam, and magnetic trap filling with ions during heating of an ion-producing substance by light in a magnetic field and during an interaction between intense light and fast-particle beams. V.Z.

A67-33055
BEHAVIOR OF SATURABLE-ABSORBER GIANT-PULSE LASERS IN THE LIMIT OF LARGE ABSORBER CROSS SECTION.
L. E. Erickson and A. Szabo (National Research Council, Div. of Radio and Electrical Engineering, Ottawa, Canada).
Journal of Applied Physics, vol. 38, May 1967, p. 2540-2542. 24 refs.

Using a rate-equation model, it is shown that the behavior of the saturable-absorber giant-pulse (SAGP) laser can be adequately described in terms of two parameters for values of the ratio of absorber to laser absorption cross section $\sigma > 200$: n_{ai}' the normalized initial inversion and $\sigma\tau_s$, where τ_s is the normalized absorber relaxation time. In the general case, specification of n_{ai}', σ, and τ_s is required. Theoretical curves of the giant-pulse output power, energy, and rise- and falltimes are presented. The results are applicable in particular to SAGP lasers employing organic-dye absorbers. (Author)

A67-33062
EXTENSION OF CO_2-LASER WAVELENGTH RANGE WITH ISOTOPES.
G. B. Jacobs and H. C. Bowers (General Electric Co., Defense Electronics Div., Electronics Laboratory, Syracuse, N.Y.).
Journal of Applied Physics, vol. 38, May 1967, p. 2692, 2693. 5 refs.

Demonstration of tunable laser emission in both $00^01\text{-}10^00$ and $00^01\text{-}02^00$ bands in the isotope $^{13}O^{16}O_2$ and in a mixture of the two isotopes $^{12}C^{16}O_2$ and $^{13}C^{16}O_2$. By using these isotopes, the CO_2 laser has been made to lase at any one of about two hundred lines from about 9.2 to 11.4 μ. It is pointed out that by using optimum mixtures of the many possible combinations of carbon and oxygen isotopes, the lasing wavelength range can be further increasead at the extremities and the wavelength between adjacent lasing transitions further decreased. R.B.S.

A67-33063
GENERATION AND AMPLIFICATION OF A SUBNANOSECOND LASER PULSE.
A. J. DeMaria, R. Gagosz, H. A. Heynau, A. W. Penney, Jr., and G. Wisner (United Aircraft Corp., United Aircraft Research Laboratories, East Hartford, Conn.).
Journal of Applied Physics, vol. 38, May 1967, p. 2693-2695. 10 refs.
Army-supported research.

Modification of an experimental technique by Penney and Heynau (1966), which has resulted in the generation of single laser pulses having hundreds of Mw of peak power (without amplification), subnanosecond time duration, an optical cavity length of approximately 70 cm, and approximately 100% probability of success. The length of the cavity was predominantly determined by the length of the laser rod. The amplification of single, subnanosecond laser pulses for obtaining Gw's of peak power is also reported. R.B.S.

A67-33086
PROPAGATION IN RECTANGULAR WAVEGUIDE FILLED WITH SKEW UNIAXIAL DIELECTRIC.
J. B. Davies (Sheffield, University, Dept. of Electronic and Electrical Engineering, Sheffield, England).
IEEE Transactions on Microwave Theory and Techniques, vol. MTT-15, June 1967, p. 372-376. 8 refs.
Research supported by the Mullard Research Laboratories.

A solution is given for propagation in rectangular waveguide fully loaded with a uniaxial dielectric, with the c-axis lying anywhere in the transverse plane. This problem arises in the design of particular traveling-wave masers. By application of the Rayleigh-Ritz method to Berk's variational expression, the problem is reduced to a matrix eigenvalue problem, and in a form suitable for direct evaluation on a digital computer. An explicit approximate solution is, however, shown to give accurate results. The analysis can be interpreted directly in terms of mode coupling of the usual rectangular waveguide modes, and the possible extension is indicated to general tensor media and to circular or elliptical waveguide. (Author)

A67-33161 #
MEASUREMENT OF LAMINAR FLOW DEVELOPMENT IN A SQUARE DUCT USING A LASER-DOPPLER FLOWMETER.
R. J. Goldstein (Minnesota, University, School of Mechanical and Aerospace Engineering, Dept. of Mechanical Engineering, Heat Transfer Laboratory, Minneapolis, Minn.) and D. K. Kreid.
American Society of Mechanical Engineers, Applied Mechanics Conference, Pasadena, Calif., June 26-28, 1967, Paper 67-APM-37. 6 p. 9 refs.
Members, $0.75; nonmembers, $1.50.

A system for precision measurement of fluid velocity is developed and applied to determine the laminar flow distribution in a square duct. The experimental technique consists of measuring the Doppler shift of laser radiation scattered by particles moving with the fluid. From this frequency shift, the fluid velocity is inferred. Measurements in the entrance region and fully developed flow region of a square duct indicate that the velocity profile development takes place in a somewhat longer section of the duct than had been predicted. Measurements of the fully developed flow indicate that the optical technique used is capable of measuring velocity within an accuracy of at least 0.1%. (Author)

A67-33220
GAS LASER AS A SOURCE OF ILLUMINATION.

I. V. Obreimov (Akademiia Nauk SSSR, Institut Obshchei i Neorganicheskoi Khimii, Opticheskaia Laboratoriia, Moscow, USSR).
(Akademiia Nauk SSSR, Doklady, vol. 171, Dec. 21, 1966, p. 1305-1308.)
Soviet Physics - Doklady, vol. 11, June 1967, p. 1086-1088. 9 refs.
Translation.

A67-33225
SPIN-EXCHANGE SHIFTS IN THE HYDROGEN MASER.
S. B. Crampton (Williams College, Williamstown; Harvard University, Cambridge, Mass.).
Physical Review, 2nd Series, vol. 158, June 5, 1967, p. 57-61. 25 refs.
Research supported by the Research Corp. and NSF.

Spin-exchange pulling of the $\Delta m_F = 0$ ground-state hyperfine transition in atomic hydrogen is investigated for the case of self-excited oscillation on this transition in the hydrogen maser. Frequency shifts due to mistuning the maser cavity are found to compensate spin-exchange shifts so that both can be effectively eliminated. The result bears importantly on the use of the hydrogen maser as a spectroscopic tool and frequency standard and suggests a method for determining the spin-exchange shift parameter. (Author)

A67-33294
FABRY-PEROT FRINGE ENHANCEMENT.
V. A. Gilson (California, University, Lawrence Radiation Laboratory, Livermore, Calif.).
Applied Optics, vol. 6, July 1967, p. 1217-1219. 8 refs.
AEC-sponsored research.

The experimental results are presented to show that it is possible to use a Fabry-Pérot interferometer to discriminate multi-frequency, uniphase gas laser modulation at frequencies less than the laser's Doppler bandwidth. This is done by selecting the Fabry-Pérot mirror spacing to match the laser cavity. Thus, each Fabry-Pérot mode discriminates the modulation on its own laser mode. If all of the laser modes are modulated by the same amount, the Fabry-Pérot modes will discriminate the laser modes in phase to produce Fabry-Pérot fringe enhancement at the output. This scheme was demonstrated with both a 30 and a 120-cm laser Fabry-Pérot combination. (Author)

A67-33297
A LINEAR OPTICAL MODULATOR WITH HIGH FM SENSITIVITY.
E. A. Ohm (Bell Telephone Laboratories, Inc., Crawford Hill Laboratory, Holmdel, N.J.).
Applied Optics, vol. 6, July 1967, p. 1233-1235. 6 refs.

By using potassium dihydrogen phosphate (KDP) inside a short laser cavity, a large linear frequency deviation has been achieved with a moderate modulation voltage - i.e., ±44 Mc for ±110 v. The modulation bandwidth is to 10 Mc, the modulation power is 2.5 watts and the optical output power is 0.4 mw (single mode, single frequency) at 6328 Å. The piezoelectric resonances which occur at modulation frequencies in the 80 kc to 2 Mc range have been nearly eliminated by clamping the KDP in a rigid, but highly damped, mount. As a result, the change in FM sensitivity at the fundamental theoretically discussed. In particular, it is shown that the observed polarization flip by tuning through the line center and the hysteresis effect, observed by Kannelaud and Culshaw, can be completely understood assuming a cavity whose main anisotropy is a linear phase anisotropy. At zero or very small magnetic field the theory predicts a preference for linear or circular polarization, depending on the type of atomic transition. (Author)

A67-33298
SPIKING EMISSION FROM MANY-ELEMENT LASERS.
R. Pratesi (Firenze, Università, Istituto di Fisica Superiore, Florence, Italy).
Applied Optics, vol. 6, July 1967, p. 1243-1253. 30 refs.
USAF-sponsored research.

Experimental results on the time behavior of the light emission from many-element lasers (MELs) are reported for both Fabry-Pérot and confocal geometry. Very regular relaxation oscillations can be easily obtained from the MEL in a number of working conditions. In the case of Fabry-Pérot geometry a time-resolved analysis of the spectral output, near-, and far-field patterns has been carried out in order to correlate the regular spiking behavior with the number of active modes present. The regular spiking from an MEL seems to be characteristic of single-mode operation. (Author)

A67-33299
EXPERIMENTAL TECHNIQUES IN MAKING MULTICOLOR WHITE LIGHT RECONSTRUCTED HOLOGRAMS.
L. H. Lin and C. V. LoBianco (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
(Optical Society of America, Meeting, San Francisco, Calif., Oct. 19-21, 1966, Paper.)
Applied Optics, vol. 6, July 1967, p. 1255-1258. 7 refs.

Discussion of the nature of the difficulties often encountered in making high quality multicolor holograms reconstructed in white light. Many practical problems may result from the characteristics of the available white light sources, lasers and photographic emulsions, as well as the environmental condition of a laboratory. Techniques useful to the solutions of these problems are presented, such as increasing the coherence length of a laser with little sacrifice in power, improving the signal-to-noise ratio in the reconstruction, controlling the shrinkage of the emulsion to eliminate color shift, and increasing the speed of Kodak 649F emulsion. (Author)

A67-33302
PLASTIC FIBER OPTICS. I.
R. G. Brown (Du Pont de Nemours and Co., Inc., Plastics Dept., Experimental Station, Wilmington, Del.).
Applied Optics, vol. 6, July 1967, p. 1269, 1270.

Summary of an inquiry into the ability of Crofon plastic fiber optics to transmit ruby-laser radiation. The specific objective was to determine the energy density threshold for damage, which appears to range from about 100 to 150 joules/cm. For samples irradiated at energy densities above, but near the damage threshold, damage was limited to a region near the input surface and was easily repaired. F.R.L.

A67-33310
GaAs SEMICONDUCTOR LASER OPTICALLY EXCITED BY RADIATION HAVING ENERGY CLOSE TO THE FORBIDDEN BAND WIDTH.
N. G. Basov, A. Z. Grasiuk, V. F. Efimkov, and V. A. Katulin (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Fizika Tverdogo Tela, vol. 9, Jan. 1967, p. 88-101.)
Soviet Physics - Solid State, vol. 9, July 1967, p. 65-74. 14 refs.
Translation.
[For abstract see issue 09, page 1512, Accession no. A67-21973]

A67-33312
INJECTION LUMINESCENCE OF EPITAXIAL HETEROJUNCTIONS IN THE GaP-GaAs SYSTEM.
Zh. I. Alferov, D. Z. Garbuzov, V. S. Grigor'eva, Iu. V. Zhiliaev, L. V. Kradinova, V. I. Korol'kov, E. P. Morozov, O. A. Ninua, E. L. Portnoi, V. D. Prochukhan, and M. K. Trukan (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR).
(Fizika Tverdogo Tela, vol. 9, Jan. 1967, p. 279-282.)
Soviet Physics - Solid State, vol. 9, July 1967, p. 208-210. 5 refs.
Translation.
[For abstract see issue 09, page 1554, Accession no. A67-21975]

A67-33329
EFFECTS OF EXCITATION INHOMOGENEITY IN SEMICONDUCTOR LASERS PUMPED BY AN ELECTRON BEAM.

O. V. Bogdankevich, V. A. Goncharov, B. M. Lavrushin, V. S. Letokhov, and A. F. Suchkov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Fizika i Tekhnika Poluprovodnikov, vol. 1, Jan. 1967, p. 7-14.)
Soviet Physics - Semiconductors, vol. 1, July 1967, p. 4-9. 12 refs. Translation.
[For abstract see issue 10, page 1666, Accession no. A67-23648]

A67-33334
THEORY OF LASER EMISSION BY BAND-BAND TRANSITIONS IN AN IMPURITY SEMICONDUCTOR WHEN THE CRYSTAL MOMENTUM IS NOT CONSERVED.
V. L. Vinetskii, V. S. Mashkevich, and G. Iu. Buriakovskii (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki, Kiev, Ukrainian SSR).
(Fizika i Tekhnika Poluprovodnikov, vol. 1, Jan. 1967, p. 54-62.)
Soviet Physics - Semiconductors, vol. 1, July 1967, p. 42-47.
14 refs. Translation.
[For abstract see issue 10, page 1666, Accession no. A67-23653]

A67-33335
THEORY OF LASER EMISSION BY INDIRECT TRANSITIONS WITH CARRIER PARTICIPATION.
V. S. Mashkevich (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki, Kiev, Ukrainian SSR).
(Fizika i Tekhnika Poluprovodnikov, vol. 1, Jan. 1967, p. 63-71.)
Soviet Physics - Semiconductors, vol. 1, July 1967, p. 48-53.
15 refs. Translation.
[For abstract see issue 10, page 1667, Accession no. A67-23654]

A67-33346
NATURE OF THE STIMULATED EMISSION OF GALLIUM ANTIMONIDE INJECTION LASERS.
Ia. E. Pokrovskii and K. I. Svistunova (Akademiia Nauk SSSR, Institut Radiotekhniki i Elektroniki, Moscow, USSR).
(Fizika i Tekhnika Poluprovodnikov, vol. 1, Jan. 1967, p. 149, 150.)
Soviet Physics - Semiconductors, vol. 1, July 1967, p. 118, 119.
6 refs. Translation.
[For abstract see issue 10, page 1667, Accession no. A67-23665]

A67-33359
BIREFRINGENT BEAM SPLITTING FOR HOLOGRAPHY.
H. J. Caulfield and W. J. Beyen (Texas Instruments, Inc., Dallas, Tex.).
Review of Scientific Instruments, vol. 38, July 1967, p. 977, 978.

Description of a device that alleviates problems experienced in the production of holograms by allowing the laser beam to strike a beam splitter and then sending each beam through some appropriate optics. The device has two new features: (1) a polarization controller, and (2) a birefringent Foster-Seeley prism. The holograms obtained are of very high quality and have no degradation. M.M.

A67-33368
POLARIZATION PROPERTIES OF A SINGLE-MODE OPERATING GAS LASER IN A SMALL AXIAL MAGNETIC FIELD.
W. Van Haeringen (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands).
Physical Review, 2nd Series, vol. 158, June 10, 1967, p. 256-272. 19 refs.

The polarization properties of a single-mode operating gas laser in a small axial magnetic field (field splitting $\ll$ natural linewidth) with an initial cavity anisotropy are considered in detail. Expressions are given for the effects on the polarization parameters due to the active medium, the external field, and the initial anisotropy of the cavity. The cooperation of these three effects is discussed. Existing theories are in this respect shown to be either incomplete or inadequate. Specializations are made to several types of atomic transitions and cavity anisotropies. A group of low-field polarization phenomena observed on the He-Ne 1.153-μ mode is theoretically discussed. In particular, it is shown that the observed polarization flip by tuning through the line center and the hysteresis effect, observed by Kannelaud and Culshaw, can be completely understood assuming a cavity whose main anisotropy is a linear phase anisotropy. At zero or very small magnetic field the theory predicts a preference for linear or circular polarization, depending on the type of atomic transition. (Author)

A67-33390 #
COMPARISON OF ROTATING MIRROR AND LIQUID BLEACHER AS A Q SWITCH FOR A RUBY LASER.
K. Hamal, V. Sochor, T. Daříček, and A. Novotný (České Vysoké Učení Technické, Fakulta Technické a Jaderné Fysiky, Prague, Czechoslovakia).
Journal of Scientific Instruments, vol. 44, July 1967, p. 548. 5 refs.

Comparison of two methods for generating giant pulses of coherent radiation - one using a rotating-mirror technique and the other, a passive Q-switch technique using cryptocyanine solution. To minimize mirror-damage troubles a semitransparent mirror consisting of plane-parallel quartz plates with the cryptocyanine solution placed between them was used. The thickness of the bleacher varied from 1 cm to 4 μm. (Author)

A67-33522 #
STATISTICS OF THE LASER RADIATION AT THRESHOLD.
F. T. Arecchi, A. Sona (Centro Informazioni Studi Esperienze, Laboratori; Milano, Università, Milan, Italy), and G. S. Rodari (Centro Informazioni Studi Esperienze, Laboratori, Milan, Italy).
Physics Letters, vol. 25A, July 17, 1967, p. 59, 60. 13 refs.
Research supported by the Consiglio Nazionale delle Ricerche.

Measurement of the ensemble distribution of the intensity fluctuations of a laser at threshold. It was found that the simultaneous measurement of linewidth and photon number at threshold gives a parameter connected to the atomic-dipole noise. M.M.

A67-33526 #
SHAPE OF WAVE FRONT AND SPATIAL EMISSION COHERENCE IN A RUBY LASER GIANT PULSE.
A. M. Leontovich, M. N. Popova, and M. Ia. Shchelev (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, May 1, 1967, p. 314-317.)
JETP Letters, vol. 5, May 1, 1967, p. 257-260. 6 refs. Translation.

Investigation of the spatial coherence and the shape of the emission wave front of a giant pulse from a ruby laser with a Pockels-cell shutter. The shutter consisted of a KDP crystal and a polarizer formed by a stack of glass plates placed between a flat mirror with a 98% reflection coefficient and a ruby crystal 120 mm long and 11.6 mm in diameter. The second mirror, located 70 mm away from the first, had a 30% reflection coefficient. The energy of the giant pulse ranged from 0.1 to 1 joule, the total pulse duration was 30 to 50 nsec. Integral photographs obtained with the aid of the Young scheme during one giant pulse have shown that the interference fringes were strongly smeared. This means that the spatial coherence is not conserved during the entire pulse - i.e., the relative phases and amplitudes at the two points investigated change. In other words, the shape of the wave front changes. P.v.T.

A67-33528 #
A ONE-DIMENSIONAL THEORY FOR OPTICAL MULTISPACE RESONATORS. I [EINE EINDIMENSIONALE THEORIE OPTISCHER VIELRAUM-RESONATOREN. I].
J. Kupka (Wrocław, Politechnika, Katedra Podstaw Telekomunikacji, Wrocław, Poland).
Hochfrequenztechnik und Elektroakustik, vol. 76, Apr. 1967, p. 43-48. 11 refs. In German.

Description of a model of a three-space resonator based on the one-dimensional theory of optical multispace resonators. The resonator is characterized by plane interfaces and a plane-wave scattering matrix. The derivation of those properties of the resonator which are responsible for the suppression of undesired natural frequencies is obtained by regarding the derivation as an eigenvalue

problem. Selection characteristics for two- and three-spaced resonators are given, and an He-Ne laser based on a three-spaced resonator is proposed. R.B.S.

A67-33630 #

ALLOWANCE FOR THE EFFECT OF A NONIDEAL CONTACT DURING LASER WELDING OF DIFFERENT MATERIALS [K UCHETU VLIIANIIA NEIDEAL'NOSTI KONTAKTA PRI SVARKE LAZEROM RAZNORODNYKH MATERIALOV].

N. N. Rykalin, A. A. Uglov, and N. I. Makarov (Akademiia Nauk SSSR, Institut Metallurgii, Moscow, USSR).

Akademiia Nauk SSSR, Doklady, vol. 174, June 1, 1967, p. 824-827. 5 refs. In Russian.

Discussion of the inhomogeneous temperature field arising in a two-layer plate with an imperfect contact between the two different materials during welding with a laser beam. A set of pertinent heat-conduction equations is derived and solved, using the Hankel and Laplace transforms. Conditions for a steady, highly localized welding effect are defined in terms of the laser pulse duration. V.Z.

A67-33648 #

NOISE AND MODULATION OF He-Ne LASER.

Uichi Kubo, Kazuo Kawabe, and Yoshio Inuishi (Osaka University, Dept. of Electrical Engineering, Osaka, Japan).

Osaka University, Technology Reports, vol. 16, Oct. 1966, p. 505-514. 9 refs.

Research supported by the NHK Spring Co.

Analysis of the noise in the output of a He-Ne laser, which arises from fluctuations of the discharge current. When the laser was excited by an rf discharge, an excess of noise was not noticed. In a dc-excited laser, there exists a critical frequency above which the noise was not detectable. This frequency is 250 kc for a visible (6328Å) laser and 50 kc for an IR (1.153 μ) laser. It was found that there is a close relationship between the critical frequency and the lifetime of the He metastable atom. This was confirmed by a modulation experiment by applying forced oscillations directly to the discharge current. The problem was studied theoretically by solving rate equations expressing the change in the population densities of the levels of interest and the energy densities of the laser emission. R. B. S.

A67-33649 #

THOMSON SCATTERING OF RUBY LASER LIGHT BY SHOCK WAVE PLASMA.

Yasukazu Izawa, Hideaki Kabuto, Masahiro Yokoyama, and Chiyoe Yamanaka (Osaka University, Dept. of Electrical Engineering, Osaka, Japan).

Osaka University, Technology Reports, vol. 16, Oct. 1966, p. 515-521. 8 refs.

Measurement of Thomson scattering of a Q-switched ruby laser beam in a shock-wave plasma. Spurious scattering of the laser light was reduced to a tolerable level by using a special chamber. In order to determine the electron density from the Thomson scattering, Rayleigh scattering at one atm was used as a measuring standard. The electron densities behind the reflected shock wave at an initial argon pressure of 1 mm Hg and at Mach numbers from 10 to 13 were found to be approximately $10^{16}/cm^3$, which is in good agreement with calculated values according to shock theory. The spectral distribution of the scattered light was also determined, and it was found to agree with the theoretical value. R. B. S.

A67-33658 #

CONSTRUCTION AND PROPERTIES OF SHORT STABLE GAS LASERS.

J. Haisma.

Philips Research Reports Supplements, no. 1, 1967, p. 1-76. 179 refs.

Description of short, stable gas lasers and discussion of some experiments conducted with such a laser. Following a brief historical review of Einstein's work on stimulated emission and the work done on stimulated emission after 1950, the construction of short plane-mirror lasers is discussed. The laser consists of a quartz-rod with a channel of suitable diameter bored along the axis and with polished matting and faces perpendicular to it, arranged in such a way that the reflecting elements - i.e., mirrors fitted on an optical flat window opposite the discharge channel - give a vacuum-tight seal merely by adhesion. The properties of this type of laser are given. The laser can be provided with a piezoelectric tuning element, which enables frequency-dependent measurements to be carried out. An experiment on thermal tuning shows the behavior of a transverse multi-mode laser as a function of the tuning and the input power of the gas discharge. Dynamic-amplification measurements, dispersion measurements, the mode spectrum and mode interaction in the laser, the analysis and behavior of combination tones, and variable-gain characteristics of a short, stable confocal laser are also discussed. R.B.S.

A67-33671 #

MEASUREMENTS OF THE SPEED OF LIGHT WITH A He-Ne GAS-LASER AS THE SOURCE OF LIGHT [LICHTGESCHWINDIGKEITS-MESSUNGEN MIT EINEM He-Ne-GASLASER ALS LICHTQUELLE].

A. Karolus and J. Helmberger (Deutsches Geodätisches Forschungsinstitut, I. Abteilung, Munich, West Germany).

Annalen der Physik, vol. 19, no. 7-8, 1967, p. 390-416. 8 refs. In German.

Research supported by the Stiftung Volkswagenwerk and the Deutsche Forschungsgemeinschaft.

Determination of the speed of light in a vacuum by using a He-Ne laser as the source of light and dividing the laser light into two even parts: measurement light and comparison light. The measurement light impinges, in counterphase to the comparison light, on the cathode of a photomultiplier. If amplitudes of the measurement light and the comparison light are equal, the modulation of the photoelectric current goes through zero. The velocity of light in a vacuum was calculated by means of the Edlen dispersion equation from the group velocity in air, using meteorological data (temperature, atmosphere pressure, atmospheric humidity) determined in each series of measurements. An attempt was made to discover systematic errors by making changes in the measuring processes. P.v.T.

A67-33672 #

DISAPPEARANCE OF THE LASER EFFECT WITH VERY STRONG PUMPING [VERSCHWINDEN DES LASER-EFFEKTES BEI SEHR STARKEM PUMPEN].

W. Brunner, H. Paul, and G. Richter (Deutsche Akademie der Wissenschaften, Institut für spezielle Probleme der theoretischen Physik, Berlin, East Germany).

Annalen der Physik, vol. 19, no. 7-8, 1967, p. 417-420. 7 refs. In German.

Demonstration that with sufficiently strong pumping a laser stops oscillating when the pumping mechanism reaches the lower level of the laser transition. This effect can be interpreted as a consequence of line broadening due to the action of the pumping "strokes." P.v.T.

A67-33714

ESTIMATION OF THE TEMPERATURE GRADIENT IN STEADY-STATE THERMALLY OPERATED SOLID-STATE LASERS [ABSCHÄTZUNG DES TEMPERATURGRADIENTEN IN THERMISCH STATIONÄR BETRIEBENEN FESTKÖRPERLASERN].

G. Zeidler (Siemens AG, Zentral-Laboratorium für Nachrichtentechnik, Munich, West Germany).

Zeitschrift für Naturforschung, Ausgabe A, vol. 22a, June 1967, p. 909-913. 13 refs. In German.

Evaluation of the temperature gradient in continuously and quasi-continuously operated solid-state lasers. The light paths in the thermally stratified medium and the thermal curvatures of the end faces are calculated and taken into consideration by means of equivalent focal distances. In this manner possibilities for a correction of various resonator modes are obtained. It is shown that

an optical resonator which can be corrected by simple means is possible when the pumping light illuminates the crystal homogeneously. P.v.T.

A67-33724
INVESTIGATION OF A NEODYMIUM-GLASS LASER WITH EXTERNAL FEEDBACK.
A. M. Bonch-Bruevich, V. Iu. Petrun'kin, V. N. Arzumanov, N. A. Esepkina, Ia. A. Imas, S. V. Kruzhalov, L. N. Pakhomov, and V. A. Chernov.
(Zhurnal Tekhnicheskoi Fiziki, vol. 36, Dec. 1966, p. 2171-2174.)
Soviet Physics - Technical Physics, vol. 11, June 1967, p. 1621-1623. Translation.

A67-33725
INVESTIGATION OF A NEODYMIUM-GLASS LASER WITH SPHERICAL MIRRORS.
A. M. Bonch-Bruevich, N. A. Esepkina, Ia. A. Imas, N. A. Pavlenko, L. N. Pakhomov, V. Iu. Petrun'kin, and S. E. Potapov.
(Zhurnal Tekhnicheskoi Fiziki, vol. 36, Dec. 1966, p. 2175-2180.)
Soviet Physics - Technical Physics, vol. 11, June 1967, p. 1624-1627. 7 refs. Translation.

A67-33726
SOME FEATURES OF PULSED OPERATION OF A He-Ne LASER.
T. M. Perchanok, V. M. Russov, and S. A. Fridrikhov (Leningradskii Politekhnicheskii Institut, Leningrad, USSR).
(Zhurnal Tekhnicheskoi Fiziki, vol. 36, Dec. 1966, p. 2188-2190.)
Soviet Physics - Technical Physics, vol. 11, June 1967, p. 1633, 1634. 9 refs. Translation.

A67-33729
ACCELERATION OF AN OSCILLATOR BY LASER RADIATION.
V. B. Krasovitskii and V. I. Kurilko.
(Zhurnal Tekhnicheskoi Fiziki, vol. 36, Dec. 1966, p. 2210-2212.)
Soviet Physics - Technical Physics, vol. 11, June 1967, p. 1653, 1654. 7 refs. Translation.

A67-33730
CONTINUOUS OPERATION WITH NITROGEN COOLING FOR INJECTION LASERS AND THE TEMPERATURE DEPENDENCE OF THE THRESHOLD CURRENT.
P. G. Eliseev, I. Ismailov, A. I. Krasil'nikov, M. A. Man'ko, and V. P. Strakhov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow USSR).
(Zhurnal Tekhnicheskoi Fiziki, vol. 36, Dec. 1966, p. 2213-2215.)
Soviet Physics - Technical Physics, vol. 11, June 1967, p. 1655, 1656. 17 refs. Translation.

A67-33731
USE OF A SEMICONDUCTOR MIRROR FOR LASER Q-SWITCHING.
P. G. Eliseev and M. A. Man'ko (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Zhurnal Tekhnicheskoi Fiziki, vol. 36, Dec. 1966, p. 2215, 2216.)
Soviet Physics - Technical Physics, vol. 11, June 1967, p. 1657, 1658. Translation.

A67-33746 #
TIME CONSTANTS OF SOME FAST PHOTODETECTORS MEASURED USING AN INDIUM ARSENIDE LASER.
M. A. C. S. Brown, P. Porteous, and D. J. Solley (Ministry of Technology, Royal Radar Establishment, Great Malvern, Worcs., England).
Journal of Scientific Instruments, vol. 44, June 1967, p. 419-421. 5 refs.

Description of an apparatus which, using a mercury wetted relay pulser and an epitaxial InAs diode laser, will produce light pulses with a rising edge of about 1 nsec. This fast edge has been used to measure the time constant of some commercially available photodetectors. (Author)

A67-33747 #
AN ABSOLUTE METHOD FOR MEASURING THE ENERGY OUTPUT OF A LASER.
A. J. Schmidt and R. C. Greenhow (York, University, Dept. of Physics, York, England).
Journal of Scientific Instruments, vol. 44, June 1967, p. 468, 469.

Description of a laser output meter in which the detector element is a hollow sphere consisting of one piece of insulated, thin copper wire tangled into a ball ("rat's nest"). Light coming through a small hole into the sphere is totally absorbed. The change in resistance caused by the change of temperature is measured by a dc Wheatstone bridge. This hollow "rat's nest" is simple to calibrate by heating with known current pulses. A practical hollow "rat's nest" calorimeter is described. (Author)

A67-33760
SPECTROSCOPIC INVESTIGATION OF GAS DISCHARGE FOR ARGON ION-OPTICAL LASERS.
V. F. Kitaeva, Iu. I. Osipov, and N. N. Sobolev (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Akademiia Nauk SSSR, Doklady, vol. 172, Jan. 11, 1967, p. 317-319.)
Soviet Physics - Doklady, vol. 12, July 1967, p. 55, 56. Translation.
[For abstract see issue 15, page 2501, Accession no. A67-30003]

A67-33826
DETONATIVE IGNITION INDUCED BY SHOCK MERGING.
P. A. Urtiew and A. K. Oppenheim (California, University, College of Engineering, Div. of Aeronautical Sciences, Berkeley, Calif.).
IN: SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, 11TH, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIF., AUGUST 14-20, 1966, PROCEEDINGS. [A67-33778 18-33]
Symposium supported by the British Section of the Combustion Institute, U.S. Army and U.S. Air Force, Grant No. DA-ARO(D)-31-124-G841, NASA, Grant No. NGR 39-003-005, National Science Foundation, NSF Grant No. GP-5734.
Pittsburgh, Pa., Combustion Institute, 1967, p. 665-670. 14 refs. Grant No. AF AFOSR 129-65.

Quantitative analysis of detonative ignition induced by the shock-merging process ahead of an accelerating flame, by means of stroboscopic laser-schlieren photography. It is demonstrated that, under such circumstances, in a hydrogen-oxygen mixture of $4H_2 + 3O_2$ initially at 0.1 atm and 300°K, the transition is produced by a chemicokinetic branched-chain explosion. M.M.

A67-33885 *
REFLECTANCE AND RELATIVE TRANSMITTANCE OF LASER-DEPOSITED IRIDIUM IN THE VACUUM ULTRAVIOLET.
James A. Samson, J. P. Padur, and A. Sharma (GCA Corp., Bedford, Mass.).
Optical Society of America, Journal, vol. 57, July 1967, p. 966, 967. 6 refs.
NASA-supported research.

Analysis showing that thin films of high-melting-point materials - in particular Ir - can be evaporated by the focused beam of a laser. Films several hundred angstroms thick can be produced by a single laser pulse in a few microseconds. The use of a laser to produce thin films for optical studies in the vacuum UV has several advantages over conventional evaporation techniques - namely, the speed of

deposition of the films, the simplicity of evaporating films in an ultrahigh-vacuum system, the lack of contamination from hot filaments or crucibles, and the ability to evaporate materials with high melting points. M. F.

A67-34011
RUBY-LASER-PUMPED OPTICAL PARAMETRIC OSCILLATOR WITH ELECTRO-OPTIC EFFECT TUNING.
L. B. Kreuzer (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
Applied Physics Letters, vol. 10, June 15, 1967, p. 336-338. 10 refs.

Optical parametric oscillation has been achieved in $LiNbO_3$ in the range 1 to 1.08 μ with a peak parametric power of 38×10^3 watts. The oscillator which was tuned both by rotation of the crystal in an external optical cavity and by the electro-optic effect was pumped at 6943 Å by a ruby laser of 3×10^6 watts peak power. The observed electro-optic tuning agreed with that calculated from measured values of the electro-optic coefficients. (Author)

A67-34013
THE ANOMALOUS APPEARANCE OF LASER OSCILLATION AT 6401 Å.
Irwin Tobias and William M. Strouse (American Optical Co., Research Div., Framingham, Mass.).
Applied Physics Letters, vol. 10, June 15, 1967, p. 342-344.

Proposed explanation of the anomalous appearance of 6401 Å He-Ne laser oscillation in certain cavity configurations, attributed to the presence in the active medium of a radial variation in the density of neon atoms in the $1s_5$ metastable level. Experiments are described which test this hypothesis. The results are consistent with it. F.R.L.

A67-34014
A SEALED-OFF MICHELSON TYPE CO_2 LASER FOR DIAGNOSTIC STUDIES OF GASEOUS PLASMAS.
W. J. Witteman (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands).
Applied Physics Letters, vol. 10, June 15, 1967, p. 347-349. 6 refs.

Description of an experimental arrangement of a Michelson type CO_2 laser for plasma diagnostic studies of ac discharges. The principle of the apparatus is based on the phenomena of strong competition between the rotational transitions. If a phase shift is caused by the plasma to be studied, the intensity distribution of the lasing transitions is changed. The system has been used successfully for measuring (with a wavelength of 10.6 μ) changes in refractive index on the order of 10^{-9}. (Author)

A67-34015
SOME APPROACHES TO VACUUM UV AND X-RAY LASERS.
M. A. Duguay and P. M. Rentzepis (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
Applied Physics Letters, vol. 10, June 15, 1967, p. 350-352. 13 refs.

The ejection of electrons from inner shells of atoms through photoionization is suggested as a straightforward means of creating population inversions at vacuum UV and X-ray wavelengths. This can be accomplished by photon sources covering broad bands. Sodium vapor and solid copper are examined as possible candidates for laser action at 372 and 1.54 Å, respectively. A first-rise traveling wave pump must be used; pumping powers required for superradiant operation run into several gigawatts, with rise times ranging from 10^{-9} sec in the near-vacuum UV to 10^{-15} sec in the X-ray region. (Author)

A67-34019
INVESTIGATION OF SEMICONDUCTOR JUNCTION LASER BY ELECTROMAGNETIC WAVE THEORY.
Yasuharu Suematsu and Tetsuhiko Ikegami (Tokyo Institute of Technology, Tokyo, Japan).
Electronics and Communications in Japan, vol. 49, June 1966, p. 22-31. 9 refs. Translation.

Numerical solution of electromagnetic-wave equations for a junction laser by use of McWhorter's electromagnetic-wave model. Graphs showing the relations of threshold loss, threshold current density, lasing width near threshold, directivity of light beam, and output efficiency as a function of various laser parameters, are obtained, based on the solutions of the wave equations. The graphs are suitable for design use. F.R.L.

A67-34024
A CLASS OF CYLINDRICAL FABRY-PEROT RESONATORS.
Nobuaki Kumagai, Hiroki Mori (Osaka University, School of Engineering, Osaka, Japan), and Ken-Ichi Yoshida (Sumitomo Electric Industries, Ltd., Osaka, Japan).
Electronics and Communications in Japan, vol. 49, June 1966, p. 105-111. 9 refs. Translation.

Theoretical analysis of a cylindrical Fabry-Pérot resonator obtained by rotating the conventional Fabry-Pérot resonator around a suitably chosen symmetry axis. Resonant modes are determined by applying boundary conditions which depend on the shape of the resonator, on the concentrating waves propagating in the radial direction, and on the dispersing waves. It is found that the integral equation for resonant conditions is of the same form as that of the conventional Fabry-Pérot resonator and that its eigenfunction gives the field distribution of resonant modes, while the eigenvalue gives the diffraction loss. The advantage of applying this kind of resonator to the laser are indicated. F.R.L.

A67-34027
VIBRATIONAL ENERGY TRANSFER IN CO_2 LASERS.
C. Bradley Moore, Robert E. Wood, Bei-Lok Hu, and James T. Yardley (California, University, Dept. of Chemistry, Berkeley, Calif.).
Journal of Chemical Physics, vol. 46, June 1, 1967, p. 4222-4231. 38 refs.
Research supported by the Sulphur Institute, NSF and ARPA.

Laser-excited vibrational fluorescence measurements have been made on the asymmetric-stretching vibrational level ($00^0 1$) of CO_2. Vibration → vibration energy-transfer rates from this level due to collisions with CO_2 and with a number of other collision partners are presented. The rate of near-resonant exchange of vibrational energy between CO_2 and N_2 ($\Delta E = 18$ cm^{-1}) has been measured. The kinetics of the CO_2 laser system are analyzed in terms of a three-level scheme. Observed laser performance is compared with that calculated by use of collisional and radiative coupling rates observed in nonionized gases and of electron activation and deactivation rates estimated from CO_2 discharge systems. In accordance with the scheme presented, the relative effectiveness of small amounts of added H_2, D_2, and He on laser output parallels their effectiveness in deactivating the lower laser level. The criteria for selecting molecules with vibrational-energy-level patterns likely to produce laser systems are outlined. Attempts to produce new continuous-wave lasers in SO_2 and HCN are described. (Author)

A67-34038 #
INVESTIGATION OF PLASMA-OPTICAL EFFECTS IN A LASER AT 0.63, 1.15, AND 3.39 μ [ISSLEDOVANIE PLAZMENNO-OPTICHESKIKH EFFEKTOV V LAZERE NA DLINAKH VOLN 0.63, 1.15 I 3.39 MK].
L. F. Vellikok, A. E. Fotiadi, and S. A. Fridrikhov (Leningradskii Politekhnicheskii Institut, Leningrad; USSR).
Zhurnal Tekhnicheskoi Fiziki, vol. 37, June 1967, p. 1127-1133. 8 refs. In Russian.

Results of experimental investigation of the dependence of the radiation power of a He-Ne laser at 0.63, 1.15, and 3.39 μ on the electron concentration. The following values were determined for a 6-mm-diam tube: (1) the value of the threshold concentration for the commencement of radiation; (2) optimal concentration for maximum power; and (3) breakdown concentration corresponding to radiation breakdown. It is demonstrated that the optimal electron

concentration in the discharge rises with increased pressure of the mixture within the tube. The results indicate that suppression of rival radiation on the 3.39-μ band significantly increases the power on the 0.63-μ band and broadens the electron-concentration range necessary for radiation. Empirical formulas describing the dependence of the laser power on the electron concentration are given for all three wavelengths. T.M.

A67-34039 #
THE SPECTRUM OF A CONTINUOUS-ACTION LASER WITH A CONFOCAL RESONATOR [K VOPROSU O SPEKTRE OKG NEPRERYVNOGO DEISTVIIA S KONFOKAL'NYM REZONATOROM].
I. M. Belousova, O. B. Danilov, and V. V. Liubimov.
Zhurnal Tekhnicheskoi Fiziki, vol. 37, June 1967, p. 1134-1139. In Russian.

Examination of the spectrum of a continuous-action laser in the vicinity of the precise confocal resonator used in the laser. The experimental apparatus consisted of a confocal resonator with a length of 100 cm and a laser with a 7-mm-diam tube. The arrangement of the apparatus is described in detail. The experiments demonstrated that off-axis modes do not degenerate along the frequency in a laser with a confocal resonator. Those degenerations which were observed are associated with phase distortions of the wave front caused by mirror defects. Evaluation of the rms value of the frequency division stipulated by these phase distortions shows a correspondence with experimental results. T.M.

A67-34041 #
HEATING, BY LASER RADIATION, OF A PLASMA SITUATED IN A STRONG MAGNETIC FIELD [O NAGREVE IZLUCHENIEM LAZERA PLAZMY, NAKHODIASHCHEISIA V SIL'NOM MAGNITNOM POLE].
P. I. Skhuropat and G. A. Shneerson (Leningradskii Politekhnicheskii Institut, Leningrad, USSR).
Zhurnal Tekhnicheskoi Fiziki, vol. 37, June 1967, p. 1161-1165. In Russian.

Study of laser heating of a plasma which has a cylindrical form and is situated in a strong longitudinal magnetic field. The conditions of plasma heating are described and the broadening of the plasma along the length of the magnetic field caused by the heating process is described by a differential equation. It is demonstrated that the presence of a strong magnetic field significantly increases the heating of a plasma by a laser. The required magnetic-field strength is close to currently available limits. T.M.

A67-34042 #
A POSSIBILITY OF DECREASING THE ANGULAR DIVERGENCE OF THE RADIATION OF A SINGLE-PULSE LASER [OB ODNOI VOZMOZHNOSTI UMEN'SHENIIA UGLOVOGO RASKHOZHDENIIA IZLUCHENIIA MONOIMPUL'SNOGO OKG].
Iu. A. Anan'ev and V. D. Volosov.
Zhurnal Tekhnicheskoi Fiziki, vol. 37, June 1967, p. 1165, 1166. In Russian.

Description of a method for decreasing the angular divergence of radiation under single-pulse conditions of laser operation by using a corrective system located outside the resonator. The corrective system consisted of a thin lens with variable focal spacing. The external corrective system significantly decreased the angular radiation divergence in each of two mutually perpendicular directions. The dependence of the angular radiation divergence on the focal spacing of the corrective lens is determined. T.M.

A67-34043 #
INVESTIGATION OF THE INFLUENCE OF A LONGITUDINAL MAGNETIC FIELD ON THE OPERATION OF A He-Ne LASER IN A PULSED REGIME [ISSLEDOVANIE VLIIANIIA PRODOL'NOGO MAGNITNOGO POLIA NA RABOTU He-Ne LAZERA V IMPUL'SNOM REZHIME].
T. M. Perchanok, S. V. Pechurina, and S. A. Fridrikhov (Leningradskii Politekhnicheskii Institut, Leningrad, USSR).
Zhurnal Tekhnicheskoi Fiziki, vol. 37, June 1967, p. 1166-1169. 7 refs. In Russian.

Investigation of the influence of a longitudinal magnetic field on the radiation intensity of a He-Ne laser operating in a pulsed regime on the 1.15-μ wavelength. The pulse rate of the laser used in the experiment was 2000 pulses/sec, while the resonator was of the semiconfocal type. A solenoid with a strength varying from 0 to 1300 oe was used for the magnetic field. The dependence of the radiation power on the magnetic-field strength was studied in relation to various pressures of the gas mixture (3 to 10 mm Hg) and various amplitudes of the 0.5-μsec exciting video pulse (5 to 12 kv). The experiments were performed on a tube with Brewster-angle windows and on a tube having windows perpendicular to the laser axis. Observations of the polarization of the output radiation were also made. The results of the study are discussed and compared with the effects of a magnetic field on a laser in a continuous-operation regime. T.M.

A67-34044 #
IONIZATION RATE IN AN ELECTRICAL DISCHARGE USED FOR AN ARGON ION LASER [O SKOROSTI IONIZATSII V ELEKTRICHESKOM RAZRIADE, PRIMENIAEMOM DLIA ARGONOVOGO IONNOGO OKG].
V. F. Kitaeva, Iu. I. Osipov, N. N. Sobolev, and P. L. Rubin (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Zhurnal Tekhnicheskoi Fiziki, vol. 37, June 1967, p. 1173-1175. 6 refs. In Russian.

Experimental investigation of the ionization rate in an electrical discharge used for an argon ion laser in a continuous-operation regime by interferometric observation of the argon-ion spectral line. A Fabry-Pérot etalon, combined with a diffraction spectrograph, was used to measure the Doppler shift of the spectral lines caused by ion drift in the field of a dc discharge in argon during conditions of Ar II line generation. The results are discussed in terms of the dependence of the Ar II shift and the ion drift on the current density and the gas pressure. The ionization rate is determined for certain specific discharge conditions described in the text. T.M.

A67-34200 #
ZEEMAN EFFECT EXTINCTION OF He-Ne 6328 Å LASER LIGHT.
L. Allen, D. G. C. Jones, and Helen Simantiris (Sussex, University, School of Mathematical and Physical Sciences, Brighton, England).
Physical Society, Proceedings, vol. 91, July 1967, p. 774-778. 20 refs.

A relationship between the axial magnetic field necessary to extinguish oscillation from a Brewster-angled laser and spontaneous intensity is derived. The results are used to measure the Doppler width of the spontaneous light at 6328 Å and, after an adiabatic collision process is allowed for, to find the gas temperature. Using the same measurements, the gain of the system is evaluated as a function of input power, as is the ratio of the population of the upper and lower laser levels. (Author)

A67-34270 #
GASDYNAMIC PROCESSES IN HEATING OF A SUBSTANCE BY LASER RADIATION.
Iu. V. Afanas'ev, V. M. Krol', O. N. Krokhin, and I. V. Nemchinov (Akademiia Nauk SSSR, Institut Fiziki Zemli and Fizicheskii Institut, Moscow, USSR).
(Prikladnaia Matematika i Mekhanika, vol. 30, Nov.-Dec. 1966, p. 1022-1028.)
PMM - Journal of Applied Mathematics and Mechanics, vol. 30, no. 6, 1966, p. 1218-1225. 5 refs. Translation.

A67-34316
LASER MEASUREMENT OF EARTH-MOON DISTANCE AND SELENOGRAPHY.
A. Orszag (Ecole Polytechnique, Laboratoire de Physique, Paris, France).
IN: MEASURE OF THE MOON; INTERNATIONAL CONFERENCE ON SELENODESY AND LUNAR TOPOGRAPHY, 2ND, UNIVERSITY OF MANCHESTER, MANCHESTER, ENGLAND, MAY 30-JUNE 4, 1966, PROCEEDINGS. [A67-34301 18-30]

Conference sponsored by the Department of Astronomy of the University of Manchester and the Cambridge Research Laboratories of the U.S. Air Force.
Edited by Zdeněk Kopal and C. L. Goudas.
Dordrecht, Netherlands, D. Reidel Publishing Co. (Astrophysics and Space Science Library. Volume 8), 1967, p. 178-180. 8 refs.
Research supported by the Centre National d'Etudes Spatiales, the Centre National d'Etudes des Télécommunications, the Délégation Générale à la Recherche Scientifique et Technique, the Direction des Recherches et Moyens d'Essais, and the Committee for Laser Atmospheric and Space Applications.

Description of equipment being installed at the Pic-du-Midi Observatory for laser measurement of the distance from a given point of the lunar ground. The equipment includes an optical system, the final element of which will be a 105-cm telescope, recently installed. The light of the laser, placed behind the mirror, will be reflected onto it by means of a Cassegrain fitting. The laser, triggered by a rotating mirror, will deliver pulses of an energy of 3 joules every 4 sec; the laser beam divergency will be of about 1.5'. The receiving apparatus will serve in two capacities: (1) to receive sufficient energy to permit detection, and (2) to ensure the elimination of stray light, so that the SNR will permit echo identification. M.M.

A67-34317
INVESTIGATING THE MOON'S MOTION BY LASER RANGING.
Renne S. Julian (Hughes Aircraft Co., Aerospace Group, Research and Development Div., Culver City, Calif.).
IN: MEASURE OF THE MOON; INTERNATIONAL CONFERENCE ON SELENODESY AND LUNAR TOPOGRAPHY, 2ND, UNIVERSITY OF MANCHESTER, MANCHESTER, ENGLAND, MAY 30-JUNE 4, 1966, PROCEEDINGS. [A67-34301 18-30]
Conference sponsored by the Department of Astronomy of the University of Manchester and the Cambridge Research Laboratories of the U.S. Air Force.
Edited by Zdeněk Kopal and C. L. Goudas.
Dordrecht, Netherlands, D. Reidel Publishing Co. (Astrophysics and Space Science Library. Volume 8), 1967, p. 181-227. 34 refs.
Contract No. AF 19(628)-5172.

Demonstration of the possibility of reducing by about three orders of magnitude the current uncertainty in the physical libration parameters of the moon by differential laser ranging on two properly located reflectors. The constraints within which any optical moon ranging system must operate are considered, and the applicable physical data are presented from an engineering viewpoint. Where specific system characteristics are considered, attention is given mostly to operation with retroreflectors on the moon because this very promising method has not been previously examined extensively. M.M.

A67-34350
UNDERSTANDING CO_2 LASERS.
David R. Whitehouse (Raytheon Co., Laser Advanced Development Center, Waltham, Mass.).
Microwaves, vol. 6, July 1967, p. A6-A14. 9 refs.

Review of the design and operation of CO_2 lasers with dc excitation and fixed mirrors. Several different ways of optimizing the performance of CO_2 lasers are discussed. The principal arrangement schemes and the basic concept of operation are described. The output spectrum of CO_2 is examined and compared with other types of gas lasers. Various reflector materials are compared and evaluated, and discharge properties, electrical characteristics, and selected special characteristics of CO_2 lasers are outlined. Basic design considerations are indicated and various applications of CO_2 lasers are surveyed. T. M.

A67-34388 #
EQUATIONS OF LASER EMISSION DYNAMICS [OB URAVNENIIAKH DINAMIKI IZLUCHENIIA V OPTICHESKIKH KVANTOVYKH GENERATORAKH].
Iu. A. Tarasov and T. N. Zubarev.
Akademiia Nauk SSSR, Doklady, vol. 174, June 11, 1967, p. 1060-1062. 7 refs. In Russian.

Derivation of a set of equations describing the radiation-field amplitude and energy-level populations of a solid-state laser with a broad oscillation spectrum. An analysis of the interaction between two oscillation modes of almost identical intensity indicates that these equations may have solutions corresponding to undamped oscillations. V.Z.

A67-34415
MULTIPHOTON IONIZATION OF ATOMS. II.
G. S. Voronov, G. A. Delone, and N. B. Delone (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, Dec. 1966, p. 1660-1664.)
Soviet Physics - JETP, vol. 24, June 1967, p. 1122-1125. 10 refs. Translation.

A67-34416
DYNAMICS OF EMISSION LINE NARROWING FOR A LASER WITH NONRESONANT FEEDBACK.
R. V. Ambartsumian, P. G. Kriukov, and V. S. Letokhov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, Dec. 1966, p. 1669-1675.)
Soviet Physics - JETP, vol. 24, June 1967, p. 1129-1134. 10 refs. Translation.

A67-34417
CONTRIBUTION TO THE THEORY OF OPTICAL EXCITATION OF SEMICONDUCTORS - ABSORPTION AND DISPERSION IN SINGLE-PHOTON AND TWO-PHOTON PROCESSES.
Iu. L. Klimontovich and E. V. Pogorelova (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR).
(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 51, Dec. 1966, p. 1722-1733.)
Soviet Physics - JETP, vol. 24, June 1967, p. 1165-1171. 14 refs. Translation.

A67-34439
LASER RADIATION FIELD FOCUSED BY REAL SYSTEMS.
B. Ia. Zel'dovich and N. F. Pilipetskii (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR).
(Radiofizika, vol. 9, no. 1, 1966, p. 95-101.)
Soviet Radiophysics, vol. 9, Jan.-Feb. 1966, p. 64-68. 10 refs. Translation.

A67-34506 #
USE OF A FLASH METHOD FOR MEASUREMENT OF THERMAL DIFFUSIVITY OF ENTRY VEHICLE HEAT SHIELD MATERIALS.
G. R. Cunnington and F. J. Smith (Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Research Laboratories, Aerospace Sciences Laboratory, Palo Alto, Calif.).
IN: TEMPERATURE MEASUREMENTS SOCIETY, CONFERENCE AND EXHIBIT, 5TH, HAWTHORNE, CALIF., MARCH 14, 15, 1967, PROCEEDINGS. [A67-34501 18-14]
Studio City, Calif., Temperature Measurements Society, 1967, p. II-A-1 to II-A-9. 8 refs.

Measurement of the thermal diffusivity of entry vehicle heat shield materials over a temperature range of 300 to 2800°K by using a flash method. The experimental method and apparatus, using both a pulsed crystal laser and a xenon flash lamp, are described. Results of measurements on graphites, nylon phenolic, and carbon phenolic materials are reported, and problems associated with using the technique for this class of materials are discussed. P.v.T.

A67-34619
LASER WITH FREQUENCY SCANNING DURING THE GENERATION PROCESS.
V. I. Kravchenko, M. S. Soskin, and V. V. Tarabrov (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki, Kiev, Ukrainian SSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, May 15, 1967, p. 355, 356.)
JETP Letters, vol. 5, May 15, 1967, p. 293-295. Translation.

Study of the frequency variation and emission kinetics of a laser with a dispersive resonator, in which the maximum Q was displaced along the frequency scale during the course of the generation, within the limits of the luminescence spectrum of the active medium. The kinetics and generation spectra were investigated in the 9434-cm^{-1} band at different pumping energies and scanning rates. The advantages offered through generation with variable emission frequency are briefly examined. R.B.S.

A67-34620
NEW METHOD OF OBTAINING HIGH-RESOLUTION HOLOGRAMS.
Sh. D. Kakichashvili, V. V. Mumladze, and N. M. Ramishvili (Akademiia Nauk Gruzinskoi SSR, Institut Kibernetiki, Tiflis, Georgian SSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, May 15, 1967, p. 370-372.)
JETP Letters, vol. 5, May 15, 1967, p. 305-307. 6 refs. Translation.

Description of a new method for obtaining high-resolution holograms. A Fresnel biprism is used in place of a beam splitting plate, to reduce noise due to vibrations in the experimental laser setup. In such a setup, the physical conditions for the beam scattered by the object and the reference beam are strictly identical, and the vibrations of the Fresnel biprism do not affect the image quality. All lines on the test pattern were resolved with contrast on the image (the smallest distance between lines was 0.08 mm), and the attained angular resolution exceeded 8×10^{-5} rad. R.B.S

A67-34621
EMISSION STATISTICS OF A LASER WITH NONRESONANT FEEDBACK.
R. V. Ambartsumian, P. G. Kriukov, V. S. Letokhov, and Iu. A. Matveev (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(ZHETF Pis'ma v Redaktsiiu, vol. 5, May 15, 1967, p. 378-382.)
JETP Letters, vol. 5, May 15, 1967, p. 312-314. 10 refs. Translation.

Investigation of the statistical properties of the emission of a laser with nonresonant feedback produced by radiation scattering. It is shown that the radiation intensity within extremely narrow solid angles is subject to strong fluctuations and that the distribution function of the intensity fluctuations coincides with the distribution function of the number of photons in one quantum state of blackbody radiation at large occupation numbers. R.B.S.

A67-34623
TEMPERATURE-INDUCED CHANGES IN OPTICAL PATH LENGTH FOR A Nd-DOPED GLASS ROD DURING PUMPING.
Seymour Epstein (U.S. Army, Electronics Command, Electronic Components Laboratory, Fort Monmouth, N.J.).
Journal of Applied Physics, vol. 38, June 1967, p. 2715-2719.
9 refs.

Frame-camera interferogram data for a neodymium-doped glass rod taken during the laser pumping process have been analyzed in terms of changes in optical path length due to: (1) explicit temperature-induced changes in length and index of refraction and (2) temperature-induced stress birefringence. Criteria for compatibility of the interferogram data, the formalism, and independently determined values for the phenomenological constants involved are set up and met, after which the temperature over the rod cross section obtains. The minimum in the temperature distribution found accounts for the observed split fringes, and our qualified estimate of the temperature rise at the center of the rod is $\sim 16^{\circ}C$. Estimates of the changes in optical path length due to the various effects are made, and values for the temperature coefficients of expansion and refractive index of $0.97 \times 10^{-5}/^{\circ}C \pm 6\%$ and $-7.2 \times 10^{-7}/^{\circ}C \pm 60\%$, respectively, are submitted. (Author)

A67-34624
THEORY OF DYNAMIC OPTICAL DISTORTION IN ISOTROPIC LASER MATERIALS.
E. P. Riedel (Westinghouse Electric Corp., Atomic, Defense and Space Group, Research and Development Center, Research Laboratories, Pittsburgh, Pa.) and G. D. Baldwin (Westinghouse Electric Corp., Atomic, Defense and Space Group, Defense and Space Center, Baltimore, Md.).
Journal of Applied Physics, vol. 38, June 1967, p. 2720-2725.
16 refs.
ARPA-Navy-DOD-supported research.

Application of Fermat's principle to the analysis of pump-induced optical distortion in isotropic laser materials. This approach leads to expressions for the slope and trajectories of rays through a laser amplifier rod for a plane-wave input. These results are then used to predict ray refraction, beam divergence, and optical path length through the rod as a function of radius, time, and polarization. The index of refraction of the material is considered to change both as a result of thermal effects and as a result of the presence of an excited ion population. (Author)

A67-34625
MEASUREMENTS OF DYNAMIC OPTICAL DISTORTION IN Nd-DOPED GLASS LASER RODS.
G. D. Baldwin (Westinghouse Electric Corp., Atomic, Defense and Space Group, Defense and Space Center, Baltimore, Md.) and E. P. Riedel (Westinghouse Electric Corp., Atomic, Defense and Space Group, Research and Development Center, Research Laboratories, Pittsburgh, Pa.).
Journal of Applied Physics, vol. 38, June 1967, p. 2726-2738.
15 refs.
ARPA-Navy-DOD-supported research.

Quantitative description of the optical distortion in neodymium-doped glass which is induced by pump radiation. The optical path length at 6328 Å is found to be dependent on four primary effects: (1) change in physical length, (2) change in refractive index due to temperature rise, (3) change in index resulting from stress, and (4) change in index associated with an excited-state population of neodymium ions. Section I presents the experimental techniques used and the results obtained. Included in this section are measurements of optical-path length variations, pump-induced birefringence, change in physical length, change in refractive index, bulk temperature rise, and the deflection of a pencil of rays. Section II compares the results of Section I with the theory set forth previously. Good agreement between theory and experiment is achieved provided a term which takes account of the index change associated with an excited-state population of neodymium ions is included. This term arises from the fact that the polarizability of the neodymium ion in its excited $^4F_{3/2}$ level is different from its value in the $^4I_{9/2}$ ground level. The inclusion of this new term in the expression for the change in refractive index implies that large optical distortions can exist in "athermalized" glass. (Author)

A67-34640
MAXIMUM-EMISSION PRINCIPLE AND PHASE LOCKING IN MULTIMODE LASERS.
C. L. Tang (Cornell University, School of Electrical Engineering, Ithaca, N.Y.) and H. Statz (Raytheon Co., Research Div., Waltham, Mass.).
Journal of Applied Physics, vol. 38, June 1967, p. 2963-2968.
9 refs.
USAF-supported research.

Investigation of the phase relationships between self-locked modes in lasers. The calculations are based on a self-consistency condition. The electric field in the cavity produces in the medium nonlinear polarization terms which may then be considered acting as source terms onto which the mode oscillations lock. The self-consistency condition imposed on the phases arises from the fact that the phase-locked modes must reproduce the originally assumed electric field. The calculated phase relationships are in essential agreement with earlier predictions based on the maximum-emission principle. The latter principle assumes that the phase relations which maximize the total rate of stimulated emission should grow most rapidly and should be the ones that establish themselves in

lasers. Additional evidence is given for the validity of the maximum-emission principle. In either calculation the basic physical mechanism that is responsible for the phase-locking effect is the nonlinear saturation in the laser medium or some saturable absorber.
(Author)

A67-34734
LASER-DRIVEN DETONATION WAVES IN GASES.
J. W. Daiber and H. M. Thompson (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.).
Physics of Fluids, vol. 10, June 1967, p. 1162-1169. 13 refs.
Contract No. AF 33(657)-8860.

The plasma created by the output of a 2- to 10-joules Q-switched ruby laser focused into air, argon, helium, and hydrogen at pressures from 15 to 1000 psi has been photographically recorded during and after the laser heating pulse. The growth of the luminous plasma front during laser irradiation was in accordance with a prediction based on a radiatively supported detonation-wave model in which a Gaussian pulse shape was used for the instantaneous energy addition. With hydrogen at atmospheric pressure, an appreciable fraction of the laser energy was transmitted. Consequently, the detonation-wave model had to include only partial absorption of the incident laser beam. This was done by using the inverse bremsstrahlung absorption coefficient and a constant depth of energy addition. The shock wave created by this sudden energy addition was observed by using a Schlieren system. The growth of the shock wave was not in accordance with that predicted by spherical-blast-wave theory. The shock-wave position from the initial point of breakdown varied as time from breakdown to the (0.20 ± 20%) power, irrespective of gas species or operating condition. (Author)

A67-34752
TURBULENT FLOW MEASUREMENTS UTILIZING THE DOPPLER SHIFT OF SCATTERED LASER RADIATION.
R. J. Goldstein and W. F. Hagen (Minnesota, University, School of Mechanical and Aerospace Engineering, Dept. of Mechanical Engineering, Minneapolis, Minn.).
Physics of Fluids, vol. 10, June 1967, p. 1349-1352.

Determination of the probability function for the turbulent velocity in a duct flow from the frequency shift of laser illumination scattered by small particles contained in the flow. The mean turbulent velocity and the intensity of the turbulence are obtained from the results. V.Z.

A67-34773 #
EFFECT OF TEMPERATURE ON THE SPECTRUM AND THRESHOLD CURRENT OF GaAs-BASED EPITAXIAL INJECTION LASERS [O VLIIANII TEMPERATURY NA SPEKTR I POROGOVYI TOK EPITAKSIAL'NYKH INZHEKTSIONNYKH LAZEROV NA OSNOVE GaAs].
P. G. Eliseev, I. Ismailov, A. I. Krasil'nikov, and M. A. Man'ko (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Fizika i Tekhnika Poluprovodnikov, vol. 1, June 1967, p. 951-953. 7 refs. In Russian.

Note on the temperature dependence of the photon generation-threshold energy for a group of GaAs epitaxial injection lasers. The temperature-dependent behavior of the working point of these lasers is discussed. The cause of the discrepancy between the author's results and the results suggested by the formula of Dousmanis, Nelson, and Staebler is believed to be energy losses which increase with temperature, a development disregarded by the formula. V.Z.

A67-34774 #
SPECTRAL CHARACTERISTICS OF INJECTION LASERS [O SPEKTRAL'NYKH KHARAKTERISTIKAKH INZHEKTSIONNYKH LAZEROV].
P. G. Eliseev, I. Ismailov, A. I. Krasil'nikov, and M. A. Man'ko (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Fizika i Tekhnika Poluprovodnikov, vol. 1, June 1967, p. 953-955. 11 refs. In Russian.

Study of the spectral characteristics of four groups of diffusion and epitaxial GaAs injection lasers with highly doped p-n junctions. Each group contains identical individual lasers which differ from the lasers of other groups by the quality of their resonators (high, intermediate, or low). Curves of photon energy vs current density at the generation threshold are given for 77°K. The possible causes of the scatter of the points on these curves are discussed. V.Z.

A67-34799
RADIO PHYSICS 1964-1965: QUANTUM AMPLIFIERS [RADIOFIZIKA 1964-1965: KVANTOVYE USILITELI].
N. V. Karlov and A. A. Manenkov.
Edited by A. M. Prokhorov.
Moscow, Izdatel'stvo VINITI, 1966. 335 p. In Russian.

This book describes the theoretical aspects of masers and lasers, their characteristics, design, and applications. The theory of quantum amplification is studied, and an introduction to the basic concepts of paramagnetic resonance in crystals is given. Various experimental methods of observing paramagnetic resonance are described. Paramagnetic resonance in ruby crystal is considered in relation to crystallography, the structure of the EPR spectrum, and the effects of an external electric field and pressure. Similar examination is made of the paramagnetic resonance of Cr^{3+} and Fe^{3+} ions in rutile and tungstates. Inverse states and the interaction between an active medium and a radiation field are examined. Quantum microwave amplifiers are described, and the sensitivity of radio receivers using quantum amplifiers is analyzed. The design and applications of various masers are discussed. Optical-range lasers are considered briefly, and some characteristics of information reception in an optical communication system are studied. The book is intended for scientists and engineers in the fields of radio physics and electronics. T.M.

A67-34800
LASERS AND NONLINEAR OPTICS [KVANTOVYE GENERATORY SVETA I NELINEINAIA OPTIKA].
Iu. L. Klimontovich.
Moscow, Izdatel'stvo Prosveshchenie, 1966. 200 p. In Russian.

This book is a systematic description of the physical processes taking place in lasers and of the phenomena occurring in matter under the action of strong electromagnetic radiation from lasers. A detailed introduction to quantum mechanics and the quantum theory of radiation is given. A historical review of atomic models is included, and the quantum properties of electromagnetic radiation are described. The quantum theory of the atom is studied, together with the process of interaction between atoms and electromagnetic radiation. Interference of light emitted from heat sources is considered. The principles of operation of lasers are described in detail. Concepts of light amplification, temperature considerations, and the condition of self-excitation in lasers are analyzed. The design and characteristic properties of ruby, gas, and semiconductor lasers are discussed. Theoretical and experimental aspects of nonlinear optics are treated extensively. A study is made of phenomena resulting from the presence of electromagnetic fields which are so strong that the principle of superposition of electromagnetic waves propagating through a medium is violated. The book is intended as intermediate literature between the popular and scientific levels available in general publications. T.M.

A67-34803 * #
BIPOLAR NICKEL-CADMIUM CELLS FOR HIGH-ENERGY PULSES.
Harvey N. Seiger, Arthur E. Lyall (Gulton Industries, Inc., Alkaline Battery Div., Research Laboratory, Metuchen, N.J.), and Steven Charlip (Gulton Industries, Inc., Alkaline Battery Div., Research Laboratory, Engineering Development Section, Metuchen, N.J.).
(INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, LOS ANGELES, CALIF., SEPTEMBER 26-28, 1966, TECHNICAL PAPERS, p. 271-278.)
Journal of Spacecraft and Rockets, vol. 4, Aug. 1967, p. 974-977. 6 refs.
Contracts No. DA-101-021-AMC-12509(Z); No. NAS 5-10160.
[For abstract see issue 23, page 4022, Accession no. A66-41760]

A67-34895 #
INVESTIGATION OF THE RADIATION SPECTRUM OF A NEODYMIUM GLASS LASER BY THE MOVING ACTIVE BODY METHOD [ISSLEDOVANIE SPEKTRA IZLUCHENIIA LAZERA NA STEKLE S NEODIMOM METODOM DVIZHUSHCHEGOSIA AKTIVNOGO TELA].
B. L. Livshits and A. T. Tursunov (Akademiia Nauk SSSR, Institut Obshchei i Neorganicheskoi Khimii, Moscow, USSR).
Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, June 1967, p. 1472-1477. 10 refs. In Russian.

Investigation of the radiation of a neodymium glass laser for the purpose of demonstrating that the random structure of the spectrum contains a spatial inhomogeneity of the mode field in relation to the active centers. By the use of the moving active body method it is experimentally demonstrated that the spatial inhomogeneity of the resonator mode field and the separation of the working volumes of the various modes caused by the inhomogeneity are responsible for the random structure of the radiation spectra of neodymium glass lasers. It is concluded that the random structure of the spectrum may be a universal characteristics of solid-state lasers. The elimination of the random effect with simultaneously assured high directivity of emission may be accomplished by the moving active body method if the resonant structure of the field within the resonator is not disturbed. T.M.

A67-34897 #
SOME FEATURES OF THE INTERACTION BETWEEN MATTER AND SHORT PULSES OF LASER RADIATION [O NEKOTORYKH OSOBENNOSTIAKH VZAIMODEISTVIIA KOROTKIKH IMPUL'SOV LAZERNOGO IZLUCHENIIA S VESHCHESTVOM].
F. V. Bunkin and A. M. Prokhorov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, June 1967, p. 1610-1615. 14 refs. In Russian.

Study of the influence of laser pulse duration on the photonuclear processes conditioned by competition between single-phonon and multiple-photon interactions of matter and radiation. As particular cases the ionization of gases and electron emission from a metal surface under the action of short laser pulses are considered. It is demonstrated that by shortening the pulse duration, it is possible to observe multiple-photon ionization in dense gases (without cascade ionization) and multiple-quantum surface photoeffects (without thermal emission of electrons). T.M.

A67-34898 #
STABILITY OF A COUNTER-TRAVELING WAVE REGIME IN A RING GAS LASER [OB USTOICHIVOSTI REZHIMA VSTRECHNYKH VOLN V KOL'TSEVOM GAZOVOM LAZERE].
Iu. L. Klimontovich, P. S. Landa, and E. G. Lariontsev (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR).
Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, June 1967, p. 1616-1631. 11 refs. In Russian.

Study of the considerations influencing the operating stability of a ring gas laser in the presence of two waves traveling in opposite directions in the ring. Equations are derived for the counter-wave amplitudes and phase differences. The width of the instability regior for a two-wave regime is determined. It is demonstrated that the width of this region decreases with increasing field amplitude. The existence of the two-wave regime is studied for the case when the Q factors of the resonator are different for the two waves. The effects of the following factors on the nature of two-wave operation are studied: (1) atomic collisions, (2) the effect of the isotopic state, and (3) the influence of wave coupling. It is demonstrated that the boundary of instability depends only weakly on the magnitude of the coupling coefficients and does not depend on it at all for equal coefficients. T.M.

A67-34903 #
SPECTRAL PROPERTIES OF A LASER WITH A LARGE ANGULAR DIVERGENCE OF LIGHT [SPEKTRAL'NYE SVOISTVA OKG S BOL'SHIM UGLOVYM RASKHOZHDENIEM SVETA].
A. M. Ratner (Akademiia Nauk Ukrainskoi SSR, Fiziko-Tekhnicheskii Institut Nizkikh Temperatur, Kharkov, Ukrainian SSR).
Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, June 1967, p. 1745-1754. 9 refs. In Russian.

Examination of the spectral characteristics of a solid-state laser having a large angular divergence of light. The large divergence results in a strong spectral overlap of longitudinal modes consequently causing a degeneration of modes at the frequency corresponding to the maximum of the amplification band. It is shown that for a sufficiently large angle of divergence, the main contribution to the integral intensity is from degenerate modes which form a narrow spectral distribution peak. The width of this peak is much smaller than the spectral width of light generated by an ordinary plane-parallel resonator. Theoretical results are confirmed by experimental data. T.M.

A67-34983 #
PULSED CIRCUIT WITH SILICON CONTROLLED RECTIFIERS FOR SEMICONDUCTOR-LASER EXCITATION [IMPUL'SNAIA SKHEMA NA KREMNIEVYKH UPRAVLIAEMYKH VENTILIAKH DLIA VOZBUZHDENIIA POLUPROVODNIKOVYKH O.K.G.].
V. I. Osinskii and V. V. Mikhnevich (Akademiia Nauk Belorusskoi SSR, Institut Fiziki Tverdogo Tela i Poluprovodnikov, Minsk, Belorussian SSR).
Pribory i Tekhnika Eksperimenta, May-June 1967, p. 99-101. 8 refs. In Russian.

Description of a pulsed-current generator with silicon controlled rectifiers and a nonlinear pulse-shaping line used for peaking the pulse leading edge. The generator is a low-ohmic pulse source producing a current with pulses up to 200 amp and a pulse buildup time no greater than 0.1 μsec. V.Z.

A67-34986 #
TWO-CHANNEL SINGLE-PULSE NEODYMIUM GLASS LASER WITH A POWER OF 180 JOULES [DVUKHKANAL'NYI MONOIMPUL'SNYI OPTICHESKII KVANTOVYI GENERATOR NA NEODIMOVOM STEKLE S ENERGIEI 180 DZH].
M. P. Vaniukov, V. A. Benchikov, V. Ia. Zhulai, V. I. Isaenko, and V. V. Liubimov.
Pribory i Tekhnika Eksperimenta, May-June 1967, p. 158-161. 10 refs. In Russian.

Description of a two-channel single-pulse laser using a system of three neodymium glass cylinders, 250 mm long and 45 mm in diameter, in each channel and producing a 180-joule pulse at a power ranging from 1.5 to 2 Gw, with a light-beam divergence angle of 3.5'. The performance and the optical features of the laser are discussed. V.Z.

A67-34987 #
A GENERATOR OF A SEQUENCE OF NANOSECOND LIGHT PULSES [GENERATOR SERII SVETOVYKH NANOSEKUNDNYKH IMPUL'SOV].
V. G. Gorbenko, V. G. Lapshin, V. I. Rykalin, Z. Tsisek, and V. P. Khromov (Ob'edinennyi Institut Iadernykh Issledovanii, Dubna, USSR).
Pribory i Tekhnika Eksperimenta, May-June 1967, p. 161-164. 7 refs. In Russian.

Description of GaP-diode-based laser producing 100 nsec-to-100 msec sequences of light pulses each lasting up to 5 to 7 nsec at 2 to 100 MHz. The device simulates with fair accuracy the operation of photoelectric amplifiers in scintillation counters under high loads and is suggested for use in studying the frequency characteristics of these amplifiers and the performance of electronic devices using scintillation or Cerenkov counters. V.Z.

A67-35034 *

QUANTUM THEORY OF AN OPTICAL MASER. I.
Marlan O. Scully and Willis E. Lamb, Jr. (Yale University, Dept. of Physics, New Haven, Conn.).
(PHYSICS OF QUANTUM ELECTRONICS; PROCEEDINGS OF THE PHYSICS OF QUANTUM ELECTRONICS CONFERENCE, SAN JUAN, PUERTO RICO, JUNE 28-30, 1965, p. 759-768; Physical Review Letters, vol. 16, May 9, 1966, p. 853-855.)
Physical Review, 2nd Series, vol. 159, July 10, 1967, p. 208-226. 62 refs.
NASA-USAF-supported research.

A67-35060

APPLICATIONS AND STATE OF DIGITAL LIGHT RAY DEFLECTION [ANWENDUNGEN UND STAND DER DIGITALEN LICHTSTRAHLABLENKUNG].
U. J. Schmidt (Deutsche Philips GmbH, Zentrallaboratorium, Abteilung angewandte Physik, Hamburg, West Germany).
Internationale Elektronische Rundschau, vol. 21, July 1967, p. 165-168. 11 refs. In German.

Study of the use of a deflected laser beam in such applications as television, machining, photo etching, space navigation, and data storage. A laboratory model of a digital beam deflector characterized by a 64-point resolution and a switching frequency of 50 kHz is described and is compared with an analog and digital beam deflector. R. B. S.

A67-35163 #

EXPERIMENTAL ANALYSIS OF LASER INDUCED GAS DISCHARGES.
C. Breton, M. Capet, V. Chalmeton, and R. Papoular (EURATOM and Commissariat à l'Energie Atomique, Groupe de Recherches sur la Fusion, Fontenay-aux-Roses, Seine, France).
IN: INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES, 7TH, BELGRADE, YUGOSLAVIA, AUGUST 22-27, 1965, PROCEEDINGS. VOLUME 1 - ELECTRONIC AND IONIC COLLISION PHENOMENA, SURFACE PHENOMENA, ELECTRICAL DISCHARGES. [A67-35067 19-25]
Edited by B. Perović and D. Tošić.
Belgrade, Građevinska Knjiga Publishing House, 1966, p. 803-806. 7 refs.

Experimental investigation of laser-induced gas discharges. It was found that the discharge is characterized by a sharp reduction of laser-light transmission through the gas, rather than by light emission from the plasma, whose time constant is longer. The corresponding instantaneous laser power is defined as the threshold power and is proportional to the focal spot diameter, but depends weakly on laser wavelength. Evidence is given of plasma heating by laser light through electron collisions. The maximum temperature reached seems to be limited by blackbody radiation. Based on these results, a thermodynamic model is suggested for the breakdown process and the steady-state discharge. M. M.

A67-35165 #

A LIGHT SPARK IN MAGNETIC AND ELECTROMAGNETIC FIELDS [SVETOVAIA ISKRA V MAGNITNOM I ELEKTROMAGNITNOM POLIAKH].
G. A. Askar'ian, M. S. Rabinovich, M. M. Savchenko, A. D. Smirnova, and V. B. Studenov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
IN: INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES, 7TH, BELGRADE, YUGOSLAVIA, AUGUST 22-27, 1965, PROCEEDINGS. VOLUME 1 - ELECTRONIC AND IONIC COLLISION PHENOMENA, SURFACE PHENOMENA, ELECTRICAL DISCHARGES. [A67-35067 19-25]
Edited by B. Perović and D. Tošić.
Belgrade, Građevinska Knjiga Publishing House, 1966, p. 810-813. 8 refs. In Russian.

Study of the perturbation arising in a magnetic and a microwave field by the action of a spark forming in the field at the focal point of a laser. The interaction of the formed plasma with the magnetic field together with the behavior of the spark plasma are studied using diamagnetic induction signals in a coil surrounding the laser's focal zone. Two main mechanisms are considered responsible for the magnetic field perturbation: the presence of a plasma fireball and the motion of ionized matter in the spark shock wave. The possible use of magnetic fields for spark-plasma containment, acceleration, and raking is considered. Results are obtained for the magnitude and lifetime of the plasma magnetic moment which may be used to estimate the extent of acceleration and ejection of plasma using nonuniform magnetic fields. T. M.

A67-35166 #

ON THE IONIZATION OF A GAS IN A FOCUSED LASER BEAM.
V. E. Mitsuk, V. I. Savoskin, and V. A. Chernikov (Moskovskii Gosudarstvennyi Universitet, Fizicheskii Fakul'tet, Moscow, USSR).
IN: INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES, 7TH, BELGRADE, YUGOSLAVIA, AUGUST 22-27, 1965, PROCEEDINGS. VOLUME 1 - ELECTRONIC AND IONIC COLLISION PHENOMENA, SURFACE PHENOMENA, ELECTRICAL DISCHARGES. [A67-35067 19-25]
Edited by B. Perović and D. Tošić.
Belgrade, Građevinska Knjiga Publishing House, 1966, p. 813-816. 9 refs.

The threshold conditions of ionization of gases - argon, deuterium, and air - at atmospheric pressure and lower under the action of radiation of a ruby laser are investigated. The spectral diagnosis of the plasma created by gas breakdown at optical frequencies is carried out. The experimental results are compared with the cascade theory of gas breakdown by means of optical pulse. (Author)

A67-35239 #

THE FRENCH LASER TELEMETRY NETWORK [LE RESEAU FRANCAIS DE TELEMETRIE PAR LASER].
R. Bivas.
COSPAR, Plenary Meeting, 10th, London, England, July 24-29, 1967, Paper. 13 p. In French.

Application of laser techniques in the D1-C satellite program to a local spatial geodesy program for the purpose of studying, perfecting, and comparing new telemetry methods. The French observation network comprises three stations located in France, in Greece, and in the Sahara, equipped to measure the Doppler effect and to carry out laser telemetry. Experimental equipment, in addition to the satellite, consists of a Q-switched ruby laser and a receiver mounted in a tracking tower, coupled to an electronic chronometer and a recording clock. Suitable satellites for this method of trajectory plotting are the S-66, BE-C, GEOS, D1-C, and D1-D. Measurements made from these satellites are said to be of good accuracy. The quantity and quality of the measurements obtained indicates that the laser telemetry system is now operational. F. R. L.

A67-35240 #

LASER TELEMETRY STARTING WITH THREE STATIONS [TELEMETRIE PAR LASER A PARTIR DE TROIS STATIONS].
R. Bivas.
COSPAR, Plenary Meeting, 10th, London, England, July 24-29, 1967, Paper. 10 p. In French.

Analysis of the effects of various errors on the accuracy of geodetic results obtained by means of a 3-station laser telemetry station. Errors are classified according to their origin or according to their statistical behavior, a distinction being made between random and systematic errors. In the case of laser telemetry, it is shown that these two classifications offset each other rather well. F. R. L.

A67-35385 #

INTERACTION OF LASER RADIATION WITH A PLASMA [O VZAIMODEISTVII S PLAZMOI IZLUCHENIIA OPTICHESKIKH KVANTOVYKH GENERATOROV].

V. A. Liperovskii and V. N. Tsytovich (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
IN: INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES, 7TH, BELGRADE, YUGOSLAVIA, AUGUST 22-27, 1965, PROCEEDINGS. VOLUME 2 - PLASMA PHYSICS. [A67-35338 19-25]
Edited by B. Perović and D. Tošić.
Belgrade, Građevinska Knjiga Publishing House, 1966, p. 456-462. 11 refs. In Russian.

Analysis of the possible nonlinear effects during interaction between a laser beam and a plasma on the basis of the general theory of interaction between rf radiation and plasma. Attention is given to fairly dense plasmas, with an electron density $n \gtrsim 10^{17}$ cm^{-3}, in which the nonlinear effects may be significant. The propagation of laser radiation through a turbulent plasma is considered, and the effects of longitudinal and transverse waves are discussed. The breakdown of transverse waves in plasma is studied for the case of narrow spectra, and the possibility of diagnosing turbulent plasma by the number and intensity of observed satellites is examined. The role of electron collisions and of external magnetic fields is discussed.
T.M.

A67-35420
ABSORPTION INDUCED BY AN INTENSE LIGHT WAVE IN VARIOUS LIQUIDS [ABSORPTION INDUITE PAR UNE ONDE LUMINEUSE INTENSE DANS DIFFERENTS LIQUIDES].
Michel Paillette (Compagnie Générale de Télégraphie sans Fil, Département de Recherches Electrooptiques, Orsay, Seine-et-Oise, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 26, June 26, 1967, p. 1795-1798. In French.

Observation that the transmission of aqueous solutions of copper and nickel salts, of benzene, and of sulfur solutions at 4880 Å decreases under the effect of the irradiation of a ruby-laser beam. Numerical results which account for this phenomenon are presented.
M.F.

A67-35421
RAMAN EFFECT OF COLORED SUBSTANCES - SOLUTIONS OF POTASSIUM, SODIUM AND AMMONIUM DICHROMATES - USE OF A He-Ne GAS LASER (6328 Å) [EFFET RAMAN DES SUBSTANCES COLOREES - SOLUTIONS DES BICHROMATES DE POTASSIUM, SODIUM, AMMONIUM - UTILISATION D'UN LASER A GAZ He-Ne (6328 Å)].
Dang Vinh Luu, Christine Clément, and Robert Lafont (Montpellier, Université, Département de Physique Cristalline, Laboratoire de Spectroscopie, Montpellier, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 264, no. 26, June 26, 1967, p. 1822-1825. 6 refs. In French.

Complete study of the role of the Raman effect in reactions involving the $Cr_2O_7^{--}$ ion. Experimental frequencies are assigned on the basis of the spectra of solutions of $Cr_2O_7K_2$, $Cr_2O_7Na_2$, $Cr_2O_7(NH_4)_2$ and of the $Cr_2O_7K_2$ single crystal.
M.F.

A67-35531 #
A METHOD FOR DETECTING STRATOSPHERIC AEROSOL PARTICLES BY THE SCATTERING OF A LASER BEAM [EIN VERFAHREN ZUM NACHWEIS STRATOSPHÄRISCHER AEROSOLPARTIKELN DURCH STREUUNG VON LASER-STRAHLUNG].
Fritz Kasten and Dieter Neumann (Mainz, Universität, Meteorologisch-Geophysikalisches Institut, Mainz, West Germany).
Beiträge zur Physik der Atmosphäre, vol. 40, no. 1-2, 1967, p. 70-94. 42 refs. In German.
Research supported by the Deutsche Forschungsgemeinschaft.

Measurement of the radiation from a ruby laser scattered at relatively small angles by aerosol particles, as a method for on-the-ground optical determination of the number and size of stratospheric aerosol particles. On the basis of the technical data of a certain laser system and by the application of the theory of light scattering to appropriate models of the size distribution of stratospheric aerosol particles, the scattered light signal incident on the aperture of the receiver is estimated. The radiative flux produced by this signal at the outlet of the optical system is compared with the corresponding radiative fluxes of the background light. The measured signal is processed by suitable electronics, the essential characteristics of which are cited with special consideration being given to the signal-to-noise ratio. In order to raise this ratio to an acceptable value, the photomultiplier is enclosed in a special cooling drum which minimizes heat transfer by conduction and radiation.
R.B.S.

A67-35546
RECORDING OF RAMAN SPECTRA EXCITED BY QUASI-CONTINUOUS AND CONTINUOUS RUBY LASERS [REGISTRIERUNG VON RAMANSPEKTREN BEI ERREGUNG MIT QUASIKONTINUIERLICHEN UND KONTINUIERLICHEN RUBINLASERN].
J. Brandmüller, K. Burchardi, H. Hacker, and H. W. Schrötter (München, Universität, Sektion Physik, Munich, West Germany).
Zeitschrift für angewandte Physik, vol. 23, no. 2, 1967, p. 112-117. 26 refs. In German.

Evaluation of a quasi-continuous (50 cps) and a continuous ruby laser as light sources for photoelectrically recording Raman spectra. By comparison with spectra excited by the He-Ne laser, the following two conclusions were drawn: (1) substances which absorb too intensely at 6328 Å give intense Raman spectra at 6943 Å (i.e., crystalline p-nitro-p'-dimethylaminoazobenzene in KBr); (2) due to the ν^4 law and the lower spectral sensitivity of the S-20 photomultiplier, the recorded intensity for nonabsorbing substances is lower.
R.B.S.

A67-35547 #
THE PHYSICS OF MASER MATERIALS.
J. W. Orton, D. H. Paxman, and J. C. Walling (Mullard, Ltd., Mullard Research Laboratories, Salfords, Surrey, England).
Philips Technical Review, vol. 28, no. 5-7, 1967, p. 146-149. 9 refs.

Discussion of two material parameters relevant to maser operation - the inverted population difference produced by a particular pumping scheme and spin-lattice relaxation. It is concluded that in cases where the concentration of paramagnetic ions is low and only two paramagnetic energy levels are involved, current theories of spin-lattice relaxation predict relaxation times in satisfactory agreement with experimental results. In a practical maser material, however, the presence of further levels and increased magnetic ion concentration leads to complicating factors which make theoretical prediction more difficult.
M.F.

A67-35593 #
A MONOCHROMATOR OF GREAT FLEXIBILITY FOR LASER LIGHT SCATTERED BY HIGH TEMPERATURE PLASMAS.
E. Glock (Institut für Plasmaphysik GmbH, Garching, West Germany).
IN: INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES, 7TH, BELGRADE, YUGOSLAVIA, AUGUST 22-27, 1965, PROCEEDINGS. VOLUME 3 - DIAGNOSTIC METHODS AND APPLICATIONS. [A67-35585 19-25]
Edited by B. Perović and D. Tošić.
Belgrade, Građevinska Knjiga Publishing House, 1966, p. 194-196. 5 refs.

Description of a monochromator designed to measure the spectral distribution of laser light scattered by high-temperature plasmas. Laser light scattered by a high-temperature plasma displays a spectrum with several lines, their halfwidth varying from 0.2 to 100 Å. In order for the information about the plasma contained in the line profile to be useful, the whole profile must be measured in a single discharge. A monochromator built for this purpose is examined. The instrument allows for a change in the dispersion by three orders of magnitude and for splitting the line profile into ten channels. The entrance and exit slits are furnished with fiber-optical devices. Since the SNR in such scattering experiments is very poor, both the attainable accuracy and the reliability of the measurements carried out is discussed.
T.M.

A67-35594 * #
TWO WAVELENGTH LASER INTERFEROMETER FOR PLASMA DIAGNOSTICS.
W. B. Johnson, A. B. Larsen, and T. P. Sosnowski (Case Institute of Technology, Cleveland, Ohio).
IN: INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES, 7TH, BELGRADE, YUGOSLAVIA, AUGUST 22-27, 1965, PROCEEDINGS. VOLUME 3 - DIAGNOSTIC METHODS AND APPLICATIONS. [A67-35585 19-25]
Edited by B. Perović and D. Tošić.
Belgrade, Građevinska Knjiga Publishing House, 1966, p. 220-224. 11 refs.
Research supported by the Case Institute of Technology, NASA and NSF.

A method of measuring plasma electron densities in the 10^{10} to 10^{13}-electrons/cm^3 range by observing the beat frequencies between two dual frequency lasers (one perturbed by the intracavity plasma) is discussed. Expressions for the difference frequency as a function of laser wavelength and plasma electron density are derived and the experimental apparatus, designed to minimize problems due to vibration and thermal effects, is described. (Author)

A67-35622
FREQUENCY STABILIZATION OF THE FM LASER.
Russell Targ, L. M. Osterink, and J. M. French (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Mountain View, Calif.).
IEEE, Proceedings, vol. 55, July 1967, p. 1185-1192. 6 refs.
Contract No. AF 33(615)-2884.

A technique for the frequency stabilization of an FM laser is discussed. This technique employs a stabilization discriminant derived from a residual variation of the phase and amplitude of the small FM laser beat note at the modulation frequency, as the frequency of the FM carrier moves across the Doppler gain profile. A first-order analysis describes the dependence of that stabilization discriminant on δ, the mode coupling coefficient produced by the internal KDP phase modulator, and Γ, the resulting FM modulation index. Experimentally, a 50-mw He-Ne FM laser was frequency stabilized to better than one part in 10^8 on a long-term basis. In addition, the beat note at the modulation frequency was suppressed by 40 db from its free-running value. (Author)

A67-35623 *
HARMONIC MIXING AND THE HETERODYNE DETECTION OF LASER RADIATION.
L. Frenkel (NASA, Electronics Research Center, Cambridge, Mass.).
IEEE, Proceedings, vol. 55, July 1967, p. 1197.

An experiment is described in which prime and irreducible multiples of fundamental frequencies near 70 GHz are mixed with radiation from a carcinotron at 300 GHz. Forty-seven orders of mixing were observed. From the recent successful mixing of 75 GHz with radiation of a CN laser at 964 GHz, it is argued that in the above experiment 3300 GHz was actually present in the mixer. (Author)

A67-35685 *
OPTICAL SUPERHETERODYNE RECEIVER.
R. F. Lucy, K. Lang, C. J. Peters, and K. Duval (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Applied Research Laboratory, Waltham, Mass.).
Applied Optics, vol. 6, Aug. 1967, p. 1333-1342. 14 refs.
NASA-sponsored research.

Interpretation of optical communications experiments performed at 6328 Å, comparing the fading characteristics of coherent and noncoherent optical detection, over a 1-km real atmospheric path in different weather conditions. The results show that fading is less severe for noncoherent detection and that the fading characteristic for both types vary significantly with weather conditions. In addition, the similarity of optical FM to rf FM is demonstrated. The measurements were performed using a remote laser transmitter and an optical superheterodyne receiver, operating simultaneously in both a coherent and noncoherent detection mode. The receiver, tunable over a frequency range of 1 GHz at the i.f. difference frequency of 30 MHz, has automatic frequency control and also uses a precision angle tracking servo to maintain receiver spatial alignment with a remote transmitter. The angle and frequency tracking capability permit operation between moving transmitter and receiver terminals. P.v.T.

A67-35692
THE POTENTIAL OF PRESENT DAY LASERS AS SCIENTIFIC PROBES FOR INVESTIGATING THE STRUCTURE OF MATTER, USING AN EXPONENTIAL AMPLIFIER.
J. L. Hughes (Department of Supply, Weapons Research Establishment, Australian Defence Scientific Service, Salisbury, Australia).
Applied Optics, vol. 6, Aug. 1967, p. 1411-1415. 21 refs.

A survey of the techniques required to produce photon energy densities in the range 10^{17} to 10^{25} ergs/cm^3 is given. It is concluded that light amplification using rods cannot achieve these powers and the concept of the exponential amplifier is proposed. It is believed that any laser probe capable of such powers would require the use of neodymium-doped glass. Costs for this ultimate model would be comparable with those for powerful particle accelerators. Initially, the range 10^{17} to 10^{25} ergs/cm^3 could be catered for by conventional flashtube excitation. The upper limits would require excitation by photoemitting diodes, with a 100 to 200 Å band at 8800 Å capable of multikilowatt pulsed outputs over a 1-cm^2 aperture in a period much less than the 300 to 700 μsec spontaneous decay time of the laser level. If a suitable sensitizer could be found, then a wider range of photoemitting diodes could be considered. (Author)

A67-35694
A PHOTOGRAPHIC RECORDING MEDIUM FOR 10.6-μ LASER RADIATION.
John F. Forkner and Dennis D. Lowenthal (Philco-Ford Corp., Aeronutronic Div., Newport Beach, Calif.).
Applied Optics, vol. 6, Aug. 1967, p. 1419, 1420.
USAF-supported research.

Description of a technique for photography in the 10.6-μ region, discovered during investigations with the CO_2 laser where a film, originally developed for UV and visual photography, served as the recording medium. This Kalvar film is a thermoplastic resin with a UV-sensitive compound dispersed within the resin. It seems possible that, by reversing the normal film process, a means of recording CO_2 laser radiation would result. The film would be preexposed to a fixed amount of UV energy; then upon exposure to the CO_2 radiation, the absorbed 10.6 μ energy would heat the resin layer of the film and selectively develop the irradiated areas. When the film was exposed to a CO_2 laser following this procedure, remarkably good photographs were obtained of the energy distribution in the beam. P.v.T.

A67-35695
ATMOSPHERIC PROPAGATION OF LASER AND NONLASER LIGHT.
G. L. Knestrick and J. A. Curcio (U.S. Navy, Office of Naval Research, Naval Research Laboratory, Washington, D.C.).
Applied Optics, vol. 6, Aug. 1967, p. 1420, 1421.

Measurement of a difference between laser and nonlaser light transmitted by the atmosphere. The geometry of the two light beams was made as nearly the same as possible by spreading the laser beam with a pair of lenses and a pinhole and controlling the divergence and polarization of the arc light with a lens and a Polaroid filter. The cross section of each beam was scanned along the vertical and the horizontal diameters with a photocell having an angular subtense of 0.07 mrad. The concentrated arc beam was within 10% of being flat over the central 3 mrad, whereas the laser beam had a more Gaussian distribution and was somewhat elliptical. Its beamwidth at half peak intensity was 3.5 mrad vertically and 4.0 mrad horizontally. Within the scope of the measurements, no difference was found in the propagation of laser and nonlaser light in the atmosphere. P.v.T.

A67-35700
LASER HARMONICS USEFUL FOR FREQUENCY TRANSLATION.
W. S. Lovell, M. M. Anderson, and F. E. Seiller (National Bureau of Standards, Boulder, Colo.).
Applied Optics, vol. 6, Aug. 1967, p. 1430-1432. 9 refs.

Tabulation of the accidental coincidences between the fundamental frequency of one laser and the harmonic or subharmonic frequencies of another, as a necessary condition for frequency translation between lasers. Limiting the consideration to harmonics of the order of two or one half, the number of frequency (or wavelength) pairs to be examined for coincidence is approximately n^2, where n is the number of frequencies under consideration. A computer was used to compare such wavelength pairs derived from the wavelengths of approximately 880 laser transitions contained in a composite of several recent compilations. In using these compilations, where duplications of individual transitions existed, those wavelength values given to the greatest number of significant figures have been used. M. M.

A67-35701
LASER MIRROR TRANSMISSIVITY OPTIMIZATION IN HIGH POWER OPTICAL CAVITIES.
Clinton T. Meneely (USAF, Systems Command, Research and Technology Div., Avionics Laboratory, Wright-Patterson AFB, Ohio).
Applied Optics, vol. 6, Aug. 1967, p. 1434-1436.

Determination of the optimum output coupling through choice of appropriate output-mirror reflection coefficients. The optimization problem is due to the fact that the gain of the lasing line $G(\omega)$ is a function of the radiation energy density in the laser cavity, which in turn is affected by the output coupling due to the mirror transmissivities. It is assumed that $G(\omega)$ is closely approximated by Rigrod's expression: $G(\omega) = G_0/(1 + \omega/\omega_0)$. B. B.

A67-35757 #
MICROSPHERE ABLATION IN A FREE-FLIGHT RANGE.
D. J. Collins, W. K. Rogers, and D. K. Sangster (General Motors Corp., AC Electronics Defense Research Laboratories, Flight Physics Laboratory, Goleta, Calif.).
AIAA Journal, vol. 5, Sept. 1967, p. 1684, 1685.
Research supported by Sandia Corp.

Experimental determination of the feasibility of (1) launching small spherical particles having diameters ranging from 400 to 700 μ at high velocity from a ballistic free-flight range and (2) obtaining useful data on ablation behavior using the latest techniques in laser photography. A typical laser shadowgraph obtained is shown. This was a 500-μ sphere with an initial flight velocity of 7.77 km/sec. The particle shape was determined from a two-dimensional density contour map of the laser shadowgraph. The density contour map of a 700-μ sphere is shown, along with two density cross sections. It is pointed out that particle shape changes of 50 μ and greater can be determined with the lasers and optical system used. M.M.

A67-35804
QUASI-LINEAR DISPERSION SPHERICAL FABRY-PEROT INTERFEROGRAMS FOR GIANT PULSE LASER SPECTROSCOPY.
D. J. Bradley (Belfast. Queen's University, Dept. of Physics, Belfast. Northern Ireland).
Nature, vol. 215, July 29, 1967, p. 499-501. 10 refs.
Research supported by the Science Research Council.

Outline of the use of spherical interferometers to measure the time-resolved spectra of ruby laser relaxation oscillations and for the direct spectral detection of off-axis modes in giant-pulse ruby lasers and an intensity-dependent frequency shift. In these situations the spherical instrument has the advantage of high illumination intensity of the detector and good plate adjustment. Calculation of the structure of the interference fringe pattern for a particular mirror separation considering the optical path difference between successively reflected rays as a function of the ray zonal radius is described. B. B.

A67-35810
LASER-INDUCED BREAKDOWN IN METAL VAPOURS.
J. W. Gardner (English Electric Co., Ltd., Leicester, England).
International Journal of Electronics, First Series, vol. 22, Feb. 1967, p. 123-131. 23 refs.

A theory of multiquantum photo-ionization is applied to interpret some recent measurements (Rizzo and Klewe, 1966) of optical breakdown thresholds in cesium and rubidium vapors. It is concluded that ionization occurs by a mixture of direct and indirect (two-photon resonance) processes, the latter predominating as the atomic density of each vapor increases. (Author)

A67-35814
THE DAMPING OF MOVING STRIATIONS BY H.F. DISCHARGE IN A He-Ne LASER.
J. P. Novák (Karlova Universita, Katedra Elektroniky a Vakvove Fysiky, Prague, Czechoslovakia).
International Journal of Electronics, First Series, vol. 22, Feb. 1967, p. 189-191. 7 refs.

Study of the damping effect of an hf field on the instabilities occurring in the form of moving striations within the plasma of a gas laser. It is found that when a sufficiently strong hf field is applied, the self-excitation of the moving striations is repressed and the resulting amplitude modulation of the laser beam is eliminated. No change occurs in the beam's power. The dependence of the boundary discharge current of the striations on the intensity of hf current was also investigated. T.M.

A67-35997 * #
TEST PERFORMANCE OF AN EXPERIMENTAL LASER RADAR FOR RENDEZVOUS AND DOCKING.
Charles L. Wyman (NASA, Marshall Space Flight Center, Astrionics Laboratory, Huntsville, Ala.).
American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Dynamics Conference, Huntsville, Ala., Aug. 14-16, 1967, Paper 67-606. 9 p. 5 refs.
Members, $0.75; nonmembers, $1.50.

A laser radar for rendezvous and docking has been developed over the past several years. The radar uses pulsed injection lasers for acquisition, coarse ranging, and angular tracking. The angular tracking detectors are image dissectors. An incoherent injection diode that is continuously modulated operates as the source for vernier ranging from 3 km to docking. The radar has recently undergone an extensive test and evaluation program. Static tests in the laboratory indicated a capability of ranging to an accuracy of less than 10 cm. Dynamic closed loop testing was performed on a full scale docking simulator, with the radar providing all necessary information to the simulator computer for a complete rendezvous and docking maneuver. The sequence of operation on the simulator was acquisition, angular alignment of the spacecraft, closure, and docking. Several hundred runs on the simulator were made with a successful docking each time. Long range tests were performed from mountain top to aircraft. The tests show that the radar is adaptable to any cooperative rendezvous situation, on manned or unmanned spacecraft, and will provide the necessary intelligence to the guidance computer to effect a complete rendezvous and docking operation automatically. (Author)

A67-36023 #
A METHOD OF NARROWING THE EMISSION SPECTRUM OF A RUBY LASER [OB ODNOM METODE SUZHENIIA SPEKTRA IZLUCHENIIA OKG NA RUBINE].
V. V. Antsiferov, G. V. Krivoshchekov, and K. G. Folin (Akademiia Nauk SSSR, Sibirskoe Otdelenie, Institut Fiziki Poluprovodnikov, Novosibirsk, USSR).
Radiofizika, vol. 10, no. 6, 1967, p. 879, 880. 7 refs. In Russian.

Note on an observation of spectral-line narrowing in a ruby laser during a displacement of the standing-wave field with respect to the active centers of the ruby crystal produced by the electro-optical effect. The experimental technique is described, and spectral interferograms are given. V.Z.

A67-36024 #
DIRECT LASER-FREQUENCY MEASUREMENTS [K VOPROSU O PRIAMOM IZMERENII CHASTOTY LAZERA].
M. E. Gertsenshtein (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Fiziko-Tekhnicheskikh i Radiotekhnicheskikh Izmerenii, Moscow, USSR).
Radiofizika, vol. 10, no. 6, 1967, p. 880-882. 5 refs. In Russian.

Note on a scheme for obtaining zero beats, using a broad range of phase frequency modulations for a direct determination of laser frequencies. The scheme is developed as a technically more easily realizable alternative to other conceivable theoretical concepts.
V.Z.

A67-36027 #
THEORETICAL AMPLIFICATION CHARACTERISTICS OF MULTICAVITY MASERS FOR WEAK AND STRONG MASER ACTION [TEORETYCZNE CHARAKTERYSTYKI PRZENOSZENIA MASERÓW WIELOWNĘKOWYCH DLA SILNEJ I SŁABEJ AKCJI MASEROWEJ].
M. A. Herman (Warszawa, Politechnika, Instytut Fizyki, Warsaw, Poland).
Archiwum Elektrotechniki, vol. 16, no. 2, 1967, p. 483-508. 17 refs. In Polish.

Determination of the amplification characteristics of multicavity masers for both weak and strong maser action. Using the chain matrix $\bar{A}$ formalism, theoretical relationships are derived which describe the amplification characteristics of one-, two-, and three-cavity transmission and reflection masers. The cavities are series-coupled by quarter-wavelength waveguides. Weak maser action is represented in the equivalent circuit of the cavity with the active paramagnetic crystal by a negative magnetic conductance. The magnetic quality factor is a real constant in this case. Strong maser action is represented by negative magnetic admittance dependent on the shape of the EPR absorption curve. The magnetic quality factor is in this case dependent on frequency and varies for each shape of the EPR curve. Two common cases are examined: (1) the case where the EPR absorption curve is determined by a Gaussian function, and (2) the case where the EPR absorption curve has a Lorentzian shape.
T.M.

A67-36036
DELAY OF THE STIMULATED EMISSION IN GaAs LASER DIODES NEAR ROOM TEMPERATURE.
G. E. Fenner (General Electric Co., Research and Development Center, Schenectady, N.Y.).
Solid-State Electronics, vol. 10, Aug. 1967, p. 753-764. 17 refs.

Specific experiments were conducted to investigate the validity of various models designed to explain the long time delay between the application of a current pulse and the generation of coherent oscillations in certain GaAs junction lasers near room temperature. A particular model is developed which leads to good quantitative agreement with a number of different experiments performed in the temperature range between 200 and 300°K. It is found that all facets of the delay can be explained by assuming that a moderate number of optical absorbing centers ($>10^{16}$ cm^{-3}) cause optical losses which are sufficient to prevent the diode from lasing until these centers are filled by electrons injected into the p-side of the junction. It is postulated that the relatively long filling time of these traps is caused by a Coulomb barrier, such as is displayed by double acceptors in II-VI compounds.
(Author)

A67-36102
PULSED HOLOGRAM FORMATION OF DIFFUSELY REFLECTING OBJECTS.
D. Fritzler and E. Marom (Bendix Corp., Research Laboratories Div., Southfield, Mich.).
Applied Physics Letters, vol. 11, July 1, 1967, p. 16, 17. 5 refs.

Production of improved three-dimensional reconstructed image of diffusely reflecting objects obtained by recording a hologram with a high-quality ruby laser operating in the single-pulse Q-switched mode. The resulting holograms were viewed with He-Ne laser light. In general, better reconstructions were obtained when small angles between the object and reference beams were used, thus resulting in a wider interference-fringe separation.
R.B.S.

A67-36103
LASER EMISSION FROM HF ROTATIONAL TRANSITIONS.
Thomas F. Deutsch (Raytheon Co., Research Div., Waltham, Mass.).
Applied Physics Letters, vol. 11, July 1, 1967, p. 18-20. 9 refs.

Investigation of laser action on pure rotational transitions of HF molecules formed by chemical reaction and initiated by a pulsed electrical discharge. The wavelengths, lying between 10.2 and 21.8 μ, are listed and identified.
R.B.S.

A67-36106
DIVERGENCE OF THE EMISSION OF GAS LASERS IN TEM_{nm} TYPE MODES.
F. A. Abramskii.
(Optika i Spektroskopiia, vol. 22, Apr. 1967, p. 611-613.)
Optics and Spectroscopy, vol. 22, Apr. 1967, p. 333, 334. 6 refs. Translation.
[For abstract see issue 14, page 2332, Accession no. A67-28854]

A67-36107
ON THE INTERACTION OF TRAVELING WAVES IN AN ANNULAR GAS LASER.
V. N. Lisitsyn and B. I. Troshin.
(Optika i Spektroskopiia, vol. 22, Apr. 1967, p. 666-668.)
Optics and Spectroscopy, vol. 22, Apr. 1967, p. 363, 364. Translation.
[For abstract see issue 14, page 2332, Accession no. A67-28856]

A67-36108
INFLUENCE OF PASSIVE-SHUTTER TEMPERATURE ON LASER OPERATION.
M. P. Lisitsa and N. R. Kulish.
(Optika i Spektroskopiia, vol. 22, Apr. 1967, p. 671, 672.)
Optics and Spectroscopy, vol. 22, Apr. 1967, p. 367, 368. Translation.
[For abstract see issue 14, page 2332, Accession no. A67-28857]

A67-36161
STATISTICAL RELATIONSHIPS GOVERNING THE FORMATION OF CRACKS IN POLYMETHYLMETHACRYLATE UNDER THE ACTION OF LASER RADIATION.
V. I. Vladimirov, V. A. Likhachev, S. M. Ryvkin, V. M. Salmanov, and I. D. Iaroshetskii (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Lenigrad, USSR).
(Fizika Tverdogo Tela, vol. 9, Feb. 1967, p. 539-546.)
Soviet Physics - Solid State, vol. 9, Aug. 1967, p. 411-416. Translation.

It is shown that the statistical relationships governing the fracture of polymethylmethacrylate by laser radiation can be easily explained if it is assumed that the probability of the appearance of a crack at a given point is governed only by the light flux which has passed through this point and by the statistics of fracture at "weak" points. According to this theory any given crack is affected by all the other cracks only because of the screening of the laser beam by the latter. The influence of the pulse energy and of the focal length of a lens on the screening is calculated. The results of the theory are in satisfactory agreement with experiment.
(Author)

A67-36164
TWO-PHOTON PHOTOCONDUCTIVITY IN CdS EXCITED WITH GIANT PULSES FROM RUBY LASER.
B. M. Ashkinadze, A. A. Grinberg, S. M. Ryvkin, and I. D. Iaroshetskii (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR).
(Fizika Tverdogo Tela, vol. 9, Feb. 1967, p. 601-603.)
Soviet Physics - Solid State, vol. 9, Aug. 1967, p. 461-463. 5 refs. Translation.

A study was made of the two-photon photoconductivity of CdS excited with light from a Q-switched ruby laser under conditions such that the duration of the exciting pulse of light was less than the photoconductivity relaxation time. This made it possible to determine directly both the density of generated carriers and the dependence of this density on the intensity of illumination I, which was found to be proportional to I^2. The cross section for the two-quantum absorption was found to be $\sim 3.6 \times 10^{18}$ cm^2. (Author)

A67-36171
SELF-LOCKING OF MODES IN LASERS.
H. Statz, G. A. DeMars (Raytheon Co., Research Div., Waltham, Mass.), and C. L. Tang (Cornell University, School of Electrical Engineering, Ithaca, N.Y.).
Journal of Applied Physics, vol. 38, Apr. 1967, p. 2212-2222. 13 refs.
USAF-supported research.

We investigated phase-locking effects between longitudinal modes in lasers. In order to show the general trend to be expected for a large number of oscillating modes, we treat three-, four-, and five-mode oscillations. The expected phases depend in a complicated manner upon the relaxation times T_1 and T_2 of the medium, on the degree of inhomogeneous broadening, the mode separation and location of the medium in the cavity. Simple formation of sharp output spikes at the fundamental frequency are expected where crystals like ruby or YAG are placed near the edges of the cavity. Sharp spikes at twice the fundamental frequency are expected when these solids are placed in the center of a cavity. Certain filters, when placed near the edge or center of the cavity are expected to cause similar locking effects. Gases and solids are expected to act quite differently. The calculations are based on the maximum-emission principle. Some experimental results are also presented. (Author)

A67-36172
METHOD FOR PULSEWIDTH MEASUREMENT OF ULTRASHORT LIGHT PULSES GENERATED BY PHASE-LOCKED LASERS USING NONLINEAR OPTICS.
H. P. Weber (Bern, Universität, Institut für angewandte Physik, Berne, Switzerland).
Journal of Applied Physics, vol. 38, Apr. 1967, p. 2231-2234. 10 refs.

A nonlinear-optics experimental arrangement is proposed for the measurement of the pulsewidth of ultrashort light pulses. The experiment consists of a Michelson-like arrangement in which each light pulse is split into two pulses which are delayed and polarized orthogonally to one another. The two pulses are propagated as ordinary and extraordinary rays through a nonlinear crystal whose orientation is chosen so that the second harmonic is only generated by the interaction arising from the superposition of these two pulses. The pulsewidth is obtained from the dependence of the intensity of the second harmonic upon the relative delay of the pulses. This method suggests itself for coincidence measurements of pulse delays including those due to optical path variations. The experimental arrangement is given and an analysis for light pulses from an ideal phase-locked laser is carried out. The resolution time of the coincidence method as limited by phase matching considerations is calculated. For the example of a phase-locked Nd laser and a 1-mm-thick KDP crystal the numerical value of the resolution time is about 1 psec. (Author)

A67-36175
GENERATION OF GIANT PULSES FROM A NEODYMIUM LASER WITH AN ORGANIC-DYE SATURABLE FILTER.
Lee A. Cross (Michigan, University, Dept. of Chemistry, Ann Arbor, Mich.) and Charles K. Cheng (Lear Siegler, Inc., Laser Systems Center, Ann Arbor, Mich.).
Journal of Applied Physics, vol. 38, Apr. 1967, p. 2290-2294. 10 refs.

Discussion of the discovery of saturable filter action in a common dye, rose bengal, a derivative of fluorescein, which permits the production of an extremely regular sequence of enhanced spikes from a neodymium laser. Unlike the previous dyes, the transition corresponding to the saturable absorption occurs between two excited states, not between the ground state and an excited state. The population of the lower excited state is achieved by optical pumping of the dye solution and by varying the intensity of the pumping flash lamp, the optical density of the filter may be altered, thus changing the spacing between light spikes, as well as their height. M.F.

A67-36183
OPTICAL SUBCARRIER COMMUNICATIONS.
J. H. Ward (International Telephone and Telegraph Corp., ITT Federal Laboratories Div., Optical Communications Group, San Fernando, Calif.) and M. L. Shechet (TRW Systems Group, Redondo Beach, Calif.).
Electrical Communication, vol. 42, no. 2, 1967, p. 247-260. 5 refs.

Discussion of some of the basic techniques for optical subcarrier communications, outlining three systems utilizing these techniques. It is emphasized that the use of subcarriers on an optical beam provides a great measure of versatility. The approach has advantages for a number of space-oriented missions, including long-range wide-band communication, spacecraft tracking and rendezvous, and spacecraft altimetry and landing aids. It also allows the use today of well developed radio-frequency techniques with the advantages of the newer electro-optical technologies. An expression is given for the signal-to-noise power ratio of a modulated laser beam. P.v.T.

A67-36212 #
PLASMA PRODUCTION BY LASER BEAM IRRADIATION OF A SINGLE SOLID PARTICLE.
C. DeMichelis and S. A. Ramsden (National Research Council, Ottawa, Canada).
Physics Letters, vol. 25A, July 31, 1967, p. 162, 163.

Investigation of the plasma produced by focusing a Q-spoiled ruby laser beam onto a single particle of lithium hydride suspended in a vacuum. Streak photographs were taken, and the electron temperature was measured from the soft X-ray emission, using absorber foils of different thickness. The electron temperature of 50 to 100 ev was found to be in agreement with the value obtained using Haught's calculations of plasma development. M.M.

A67-36216 #
VIBRATIONAL LEVEL INVERSION POPULATION OF POLYATOMIC MOLECULES, CO_2 LASER.
B. F. Gordietz, N. N. Sobolev, V. V. Sokovikov, and L. A. Shelepin (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Physics Letters, vol. 25A, July 31, 1967, p. 173-175. 5 refs.

Description of a method for calculating the vibration-level populations of polyatomic molecules in the electronic ground state. The problem of population calculations is considerably simplified by the introduction of vibration temperatures. The population calculation technique can be extended to other polyatomic molecules. M.M.

A67-36223 #
COLOUR CENTRES IN RUBY CRYSTALS.
G. E. Arkhangelskii, Z. L. Morgenshtern, and V. B. Neustruev (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Physica Status Solidi, vol. 22, no. 1, 1967, p. 289-295. 16 refs.

Investigation of the absorption spectra, the spectral dependence of the luminescence quantum output, glow curves, and radiation spectra of the glow curves of ruby crystals. These crystals are colored by intense light flashes or by γ-rays from Co^{60}. It is found that the absorption is greater in colored crystals, while the luminescence quantum output is smaller. The thermal decoloration of crystals is accompanied by a luminescence in the R-line region. A decrease in the Cr^{3+} ion concentration is detected in colored

crystals by ESR measurements. The similarity of all the characteristics obtained makes it possible to reach a conclusion about the identity of the color centers arising under optical and γ-irradiation of the crystals. The results obtained, together with published data, suggest that Cr^{2+} and Cr^{4+} act as color centers and that their formation under optical coloration is due to Cr^{3+} ion ionization via a two-step process. M.M.

A67-36326

ABSORPTION OF SEVERAL OPTICAL PHOTONS IN MOLECULAR CRYSTALS [ABSORPTION A PLUSIEURS PHOTONS OPTIQUES DANS LES CRISTAUX MOLECULAIRES].

J. Hanus (Compagnie Générale d'Electricité de Paris, Centre de Recherches, Département Recherches Physiques de Base, Marcoussis, Seine-et-Oise, France).

(Société Française des Electroniciens et des Radioélectriciens, Demi-Journée d'Etude sur l'Optique Non-Linéaire, France, Mar. 23, 1966, Conférence.)
L'Onde Electrique, vol. 47, July-Aug. 1967, p. 972-975. 14 refs. In French.

Extension of Jerphagnon's study of the absorption of two photons in semiconductors to the case of molecular crystals. The results obtained by the action of a laser beam on naphthalene, where the absorption of four photons may be observed, are presented. M.F.

A67-36330

DOUBLE REFRACTION IN RUBY LASER CRYSTALS WITH POLISHED 90° PRISMS [DOPPELBRECHUNG IN RUBIN-LASERKRISTALLEN MIT ANGESCHLIFFENEN 90°-PRISMEN].

Franz Hillenkamp (Gesellschaft für Strahlenforschung mbH, Physikalisch-Technische Abteilung, Munich, West Germany).

Zeitschrift für Naturforschung, Ausgabe A, vol. 22a, July 1967, p. 1127-1130. 5 refs. In German.

Discussion of the appearance of extraordinary rays from two ruby lasers with polished 90° prisms. The angle between the cylindrical axis and the optical axis in one of the crystals is 90°; in the other crystal, this angle is 60°. The effect of the orientation of the prisms on the extraordinary rays is demonstrated, and it is shown that double refraction detracts from the amplification potential of the laser and increases the divergence of the resulting ray emission. R.B.S.

A67-36354

SPECTROMETRY BY VARIABLE-WAVELENGTH LASERS [SPECTROMETRIE PAR LASERS DE LONGUEUR D'ONDE VARIABLE].

J. M. Besson (Paris, Université, Ecole Normale Supérieure, Laboratoire de Physique, Paris, France).

(Centre National de la Recherche Scientifique, Colloque sur les Méthodes Nouvelles de Spectroscopie Instrumentale, 2nd, Université de Paris, Orsay, Seine-et-Oise, France, Apr. 25-29, 1966, Exposé.)
Journal de Physique, Supplément, vol. 28, Mar.-Apr. 1967, p. C2-247 to C2-249. 6 refs. In French.

Discussion of the possibility for using variable-wavelength semiconductor lasers in infrared spectroscopy. Using hydrostatic pressure it is possible to vary continuously the emission wavelength of a semiconductor laser over several spectral octaves and thus cover the 1- to 20-μ range. Application of this technique in infrared spectroscopy will provide sources with good brightness, high spectral purity, and attractive hf-modulation capabilities. T.M.

A67-36355

USE OF A VARIABLE-LENGTH SINGLE-CAVITY LASER AS AN INSTRUMENT FOR ANALYZING ISOTOPIC DISPLACEMENTS IN THE INFRARED [UTILISATION D'UNE CAVITE LASER DE LONGUEUR VARIABLE COMME APPAREIL D'ANALYSE DE DEPLACEMENTS ISOTOPIQUES DANS L'INFRAROUGE].

J. Brochard and R. Vetter (Centre National de la Recherche Scientifique, Laboratoire Aimé Cotton, Bellevue; Paris, Université, Faculté des Sciences, Orsay, Seine-et-Oise, France).

(Centre National de la Recherche Scientifique, Colloque sur les Méthodes Nouvelles de Spectroscopie Instrumentale, 2nd, Université de Paris, Orsay, Seine-et-Oise, France, Apr. 25-29, 1966, Exposé.)
Journal de Physique, Supplément, vol. 28, Mar.-Apr. 1967, p. C2-250 to C2-254. 9 refs. In French.

Description of two new methods for measuring the small shifts of isotopic lines using the infrared transitions of a laser beam. In these two purely optical methods, which are based on different principles, a variable-length laser cavity is used as a high-resolution spectrometer. The first method uses two discharge tubes, each filled with a different isotope, aligned along a single axis. The tubes are alternatively excited at equal intervals which are much lower than the transit time of the beam. The two beams of the two isotopes are then simultaneously registered. The second method involves the separation of a monochromatic laser beam into three rays two of which pass through two tubes filled with different isotopes. The method permits the measurement of the intensity of the isotopic emissions. Preliminary measurements have been performed on 12 xenon lines. T.M.

A67-36384

RELAXATION OF THE 10.6 μ CO_2 LASER LEVELS BY COLLISIONS WITH H_2.

P. K. Cheo (Bell Telephone Laboratories, Inc., Whippany, N.J.).

Applied Physics Letters, vol. 11, July 15, 1967, p. 38-40. 7 refs.

Time characteristics of the afterglow gain of a pulsed CO_2:H_2 laser amplifier were investigated. Evidence shows that a rapid nonradiative transfer of population from the upper to the lower CO_2 laser levels occurs at higher H_2 pressures ($P \geq 2$ torr). An absorption pulse on the order of 1 msec in duration following the initial gain period is attributed to population accumulation (or a bottleneck) at the 01^01 level. (Author)

A67-36385

MULTIPLE STIMULATED BRILLOUIN SCATTERING FROM A LIQUID WITHIN A LASER CAVITY.

A. J. Alcock and C. De Michelis (National Research Council, Div. of Pure Physics, Ottawa, Canada).

Applied Physics Letters, vol. 11, July 15, 1967, p. 42-44.

By inserting a liquid cell between the ruby and the output reflector of a high-power, passively Q-switched ruby laser, marked changes in pulse shape, output power and spectral characteristics were observed. These effects are explained in terms of stimulated Brillouin scattering, from the liquid, effectively replacing reflection from the output mirror above a well-defined power level. Time-resolved Fabry-Pérot interferograms confirm this explanation and reveal that the output actually consists of a number of pulses, overlapping in time and corresponding to successive Brillouin orders. (Author)

A67-36386

LASER-INDUCED MICROWAVE SOUND BY SURFACE HEATING.

M. J. Brienza and A. J. DeMaria (United Aircraft Corp., United Aircraft Research Laboratories, East Hartford, Conn.).

Applied Physics Letters, vol. 11, July 15, 1967, p. 44-46. 10 refs.

Microwave sound of discrete frequencies has been generated by the irradiation of a solid with the uniformly spaced, ultrashort optical pulses produced by a mode-locked Nd:glass laser. The sound, rich in harmonic content, has its fundamental frequency fixed by the repetition frequency of the laser pulses. Believed to be thermally generated in the optical skin-depth where the energy is absorbed, the sound has been detected at room temperature up to 2 GHz, the tenth harmonic of the fundamental repetition frequency. Such high harmonic content indicates that the acoustic pulses have rise times significantly less than 1 nsec and demonstrates the feasibility of utilizing ultrashort laser pulses to produce ultrashort acoustic pulses. (Author)

A67-36387

QUASI-CW, HIGH NUMERICAL APERTURE, INDUCTIVELY EXCITED ION LASER.

C. B. Zarowin and C. K. Williams (International Business Machines Corp., Thomas J. Watson Research Center, Yorktown Heights, N.Y.).

Applied Physics Letters, vol. 11, July 15, 1967, p. 47, 48. 8 refs.
Contract No. AF 33(615)-3655.

Taking advantage of the wide bandwidth possible with inductive excitation at audio frequencies, square-wave excitation at 2.5 kHz

has been employed to obtain laser oscillation of the 4880-Å Ar II transition in a high numerical aperture active medium 1 cm in diam and 15 cm long, without the aid of an axial magnetic field. A 300-amp continuous plasma current was obtained at a power level of 15 kw. (Author)

A67-36389
OPTICAL SUM GENERATION OF THE TWO-FREQUENCY OUTPUT OF A GIANT PULSE RUBY LASER.
Daniel J. Bradley (Belfast, Queen's University, Belfast, Northern Ireland), George Magyar, and Martin C. Richardson (United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Culham Laboratory, Culham, Berks., England).
Applied Physics Letters, vol. 11, July 15, 1967, p. 51-53. 13 refs.

The tunable, two-frequency output of a gain-switched ruby laser, has been mixed in an ADP crystal to generate the sum frequency. A conversion efficiency for sum frequency generation equal to that of SHG (second harmonic generation) has been consistently achieved. (Author)

A67-36391
ON THE EXPLANATION OF THE SO-CALLED CN LASER.
David R. Lide, Jr. and Arthur G. Maki (National Bureau of Standards, Washington, D.C.).
Applied Physics Letters, vol. 11, July 15, 1967, p. 62-64. 9 refs. ARPA-supported research.

It is shown that the major features of the far-infrared "CN laser" are due to the HCN molecule. The intense line at 337 μ and other nearby lines are explained as transitions involving the 11^10 and 04^00 vibrational states, which are mixed by a Coriolis perturbation. The mechanism of the laser is discussed. (Author)

A67-36427 #
THE DETERMINATION OF CHROMIUM DISTRIBUTION IN LASER-RUBIES WITH NEUTRON ACTIVATION.
H. Pink.
Physica Status Solidi, vol. 21, no. 2, 1967, p. K111-K113.

Results of an attempt to reproduce chromium distribution by autoradiography. The method is based on neutron activation. As is known, most of the elements form nuclides when irradiated with neutrons, and the nuclides differ in kind, energy, and in the half-life of their radiation. The best autoradiography is produced if a strong difference exists between the half-life of the nuclide to be copied and that of the matrix. It is shown that this assumption is well satisfied by rubies, if they do not contain impurities. M.F.

A67-36431 #
SOME CHARACTERISTICS OF THE AMMONIA MASER AMPLIFIER.
R. J. Collier and T. H. Wilmshurst (Southampton, University, Dept. of Electronics, Southampton, England).
British Journal of Applied Physics, vol. 18, Aug. 1967, p. 1053-1059. 12 refs.
Research supported by the Science Research Council and the Signals Research and Development Establishment.

A theory is developed for the midband saturation characteristics of the ammonia maser amplifier and for the variation of maser bandwidth with gain. Experimental results are presented for both saturation and gain-bandwidth measurements, and these are compared with calculated values. For a gain of 20 db the output saturation power is typically 10^{-12} watts, while the bandwidth is in the region of 200 Hz. (Author)

A67-36432 #
FORMATION TIME AND RESONATOR LOSS IN A Q-SWITCHED RUBY LASER.
W. E. K. Gibbs (Department of Supply, Defence Standards Laboratories, Maribyrnong, Victoria, Australia).
British Journal of Applied Physics, vol. 18, Aug. 1967, p. 1061-1063. 8 refs.

Measurements of the variation of formation time of a Q-switched ruby laser as a function of loop gain are presented. The loop gains were calculated from integrated pump intensities and the measured resonator loss at threshold. The relationship between formation time and loop gain predicted by fast Q-switching theory was confirmed. Although large optical distortions are to be expected in rubies pumped to Q-switching levels, no indication of increasing resonator loss was found under these conditions. (Author)

A67-36492 #
CENTRIMETRIC BROADBAND TRAVELING WAVE MASER [MASER A ONDES PROGRESSIVES A LARGE BANDE EN ONDES CENTIMETRIQUES].
A. Nizery (Centre National d'Etudes des Télécommunications, Département Recherches Techniques de Base, Lannion, Côtes-du-Nord, France).
L'Echo des Recherches, Oct. 1966, p. 35-42. In French.

Simplified review of the physical phenomena involved in the functioning of a maser. A traveling wave maser developed in the CNET-Lannion laboratories is described, and results obtained are discussed. F.R.L.

A67-36494 #
SOLID-STATE LASER OPERATING CONTINUOUSLY AT AMBIENT TEMPERATURE [LASER SOLIDE A FONCTIONNEMENT CONTINU A LA TEMPERATURE AMBIANTE].
C. Pautrat (Centre National d'Etudes des Télécommunications, Département Physique, Chimie, Métallurgie, Issy-les-Moulineaux, Seine, France).
L'Echo des Recherches, Jan. 1967, p. 44-50. 13 refs. In French.

Description of a method for synthesizing neodymium-doped calcium tungstate single crystals. Rods, cut from these crystals, have shown continuous laser action at room temperature. The thresholds are 420 and 900 watts for ac and dc pumping, respectively. The output power exceeds 0.5 watt. M.F.

A67-36511
DESIGN CONSIDERATIONS FOR A SEMIPERMANENT OPTICAL MEMORY
F. M. Smits and L. E. Gallaher (Bell Telephone Laboratories, Inc., New York, N.Y.).
Bell System Technical Journal, vol. 46, July-Aug. 1967, p. 1267-1278. 27 refs.

The potential of high-speed optical memories using electro-optic or acousto-optic light deflection for address selection is examined. It is shown that for such memories the total memory capacity decreases as the third power of the addressing rate and that capacities in excess of 10^8 bits are feasible with a random access rate of 10^6 addresses/sec. A specific semipermanent memory design is described which uses a laser light source, an acoustic xy light deflector and an array of 10^4 holograms as information storage elements. Each storage element contains 10^4 bits which appear as a pattern on a semiconductor readout matrix when the storage element is illuminated through the xy deflector. Accordingly, the system has a total capacity of 10^8 bits with an access time of less than 10 μsec. (Author)

A67-36519
CONTROL SYSTEM FOR FREQUENCY STABILIZING A 6328 Å GAS LASER.
A. D. White (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
Review of Scientific Instruments, vol. 38, Aug. 1967, p. 1079-1084. 10 refs.

The design, construction, and performance of a laser frequency control system using two optical discriminators to achieve both long and short term frequency stability are described. The design philosophy emphasizes the active rather than the passive approach to stabilization; consequently, the system should be applicable to situations where intrinsic stability is difficult to achieve by mechanical or thermal techniques alone. (Author)

A67-36528
PHOTODIODE HOLDER WITH 300 PSEC RISE TIME FOR LASER STUDIES.

M. J. Lubin and W. Leising (Rochester, University, Dept. of Mechanical and Aerospace Sciences, Rochester, N.Y.).
Review of Scientific Instruments, vol. 38, Aug. 1967, p. 1157, 1158.
NSF Grant No. GK-861.

Description of a photodiode holder designed to accommodate an ITT FW-114A high-speed planar photodiode used in monitoring the output and subsequent events produced by giant pulsed lasers. The device exhibits less than 300-psec risetime response. R.B.S.

A67-36530
PULSE GENERATOR FOR STUDYING TRANSIENTS IN PLASMA LASERS.
F. M. Shofner (Tennessee, University, Space Institute and Dept. of Electrical Engineering, Tullahoma, Tenn.) and J. F. Pierce (Tennessee, University, Dept. of Electrical Engineering, Knoxville, Tenn.).
Review of Scientific Instruments, vol. 38, Aug. 1967, p. 1173-1175.

Analysis of the schematic of a pulser circuit used to study large-signal transients in plasma lasers. A typical laser discharge current risetime for a 34-cm-long helium-neon laser with a 3-mm bore is shown. R.B.S.

A67-36566 * #
OPTICAL COMMUNICATION POTENTIAL.
M. Kienitz and W. R. Young, Jr. (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Waltham, Mass.).
Canaveral Council of Technical Societies, Space Congress on the Challenge of the 1970's, 4th, Cocoa Beach, Fla., Apr. 3-6, 1967, Paper. 15 p. 10 refs.
Contract No. NAS 8-20256.

Comparison of two laser-based methods of wide-band planetary communication. With respect to the heterodyne technique, a signal-detection capability is provided under conditions of high background illumination, but a heterodyne receiver in the earth's atmosphere suffers an equivalent coherence-diameter performance limitation. Direct detection, which does not require coherent light, permits large receiving apertures under appropriate background constraints. Transmitter and receiver designs are postulated, and a realistic earth-orbital experiment is described. R.B.S.

A67-36595 * #
THE MASER EXPERIMENT.
C. Curtis Johnson (NASA, Goddard Space Flight Center, Greenbelt, Md.).
Canaveral Council of Technical Societies, Space Congress on the Challenge of the 1970's, 4th, Cocoa Beach, Fla., Apr. 3-6, 1967, Paper. 8 p.

Description of a functional maser system consisting of an amplifier, a low noise header assembly, and a superconducting magnet. The system described is used with the ATS series of satellites. The antenna-mounted support equipment includes the microwave pump, pump modulator, pump monitor, transfer switches, tunnel diode amplifier, and a noise source, as well as a closed-cycle helium refrigerator. The equipment for controlling and monitoring the system is located in the operations building. The power supplies for all the components (with the exception of the closed cycle refrigerator which is supplied with its own 440-v, 3 phase, 10-kva supply directly at the antenna) are located here. P.v.T.

A67-36639
LASER LIGHT.
C. C. Eaglesfield (International Telephone and Telegraph Corp., Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England).
London, Macmillan and Co., Ltd.; New York, St. Martin's Press, Inc., 1967. 197 p.
$6.00.

The aim of this book is to describe various types of laser that have been developed in the U.S. and abroad, and to discuss their use as modulated beams for long-distance terrestrial or space communications. The laser is described as an oscillator, differing from previous oscillators mainly in frequency. The necessary provisions for oscillation such as amplification and resonators are described and the build-up of oscillation is traced to the threshold and beyond. The three main types of laser - the ruby laser, gas laser, and semiconductor laser - are described, and laser applications in the communications field are reviewed. The reflection of radiation by polished surfaces and the various visual effects of laser light are examined. The text contains numerous line and halftone illustrations and extensive references to current world literature on the subject. R.B.S.

A67-36688
TRANSVERSE-MODE DISTRIBUTION OF EMISSION INTENSITY OF A SOLID-STATE LASER WITH PLANE MIRRORS.
Iu. A. Anan'ev.
(Zhurnal Tekhnicheskoi Fiziki, vol. 37, Jan. 1967, p. 139-149.)
Soviet Physics - Technical Physics, vol. 12, July 1967, p. 97-104.
22 refs. Translation.

Extension of a procedure proposed by Statz and Tang (1963) for estimating the angular divergence of a solid-state laser to include the case of pumping well above the laser threshold. Nonuniformities in the pumping distribution and in the distribution of passive absorption over the cross section of the laser material are taken into account. These factors are shown to exert an important effect on the angular spread of the laser beam. Perturbation theory is applied to the deformation of the laser modes through nonuniform gain in the laser medium. (Author)

A67-36689
ANGULAR DIVERGENCE OF GAS-LASER RADIATION AND INTERACTION OF ANGULAR MODES.
E. M. Belenov, E. P. Markin, and A. F. Suchkov.
(Zhurnal Tekhnicheskoi Fiziki, vol. 37, Jan. 1967, p. 150-156.)
Soviet Physics - Technical Physics, vol. 12, July 1967, p. 105-110.
12 refs. Translation.

Experimental investigation of the angular divergence of gas-laser radiation as a function of the output power; the interaction of angular modes whose spectrum determines the radiation divergence and the structure of the far field is analyzed. It is shown that the consideration of angular modes with the same longitudinal index is, in general, insufficient for the description of angular divergence. A correct description of the three-dimensional field pattern should take into account the interaction of angular modes with different axial indices. (Author)

A67-36768
A CIRCUIT-THEORETIC TREATMENT OF LASER ACTIONS.
Nobuaki Kumagai and Masaki Matsuda (Osaka, University, Faculty of Engineering, Osaka, Japan).
Electronics and Communications in Japan, vol. 49, July 1966, p. 9-15. 5 refs. Translation.

The operation of the laser has been described in the past by rate equations based on the energy-level model of the laser, treating the transition of particles between energy levels. In the paper, an equivalent electrical-circuit model corresponding to the energy-level model is introduced, and the method of describing laser action in terms of the circuit theory is discussed. Using this technique, the amplification factor of the laser and the transient behavior of the laser can be readily obtained from well known circuit analysis. This technique is not limited to the analysis of lasers but should have wide applications in the analysis of other quantum electronic devices. (Author)

A67-36823
METEOROLOGIC OBSERVATION [L'OBSERVATION METEOROLOGIQUE].
Ch. Perrin de Brichambault (Direction de la Météorologie Nationale Paris, France).
Revue Française d'Astronautique, July 1967, p. 19-26. In French.

Review of the goals and methods of meteorology, its future prospects, the possibility of obtaining additional and better knowledge of the atmosphere, and more efficient utilization of satellites. Parameters used in the measurement of solar radiation, earth's radiation, and total radiation (temperature, vapor pressure, atmospheric pressure, wind speed and direction, precipitation, and cloudness) are considered. Other parameters occasionally needed are

given, and the possibilities of new techniques based on the use of radar, lasers, supersonic generators, and radioactive compounds, are discussed. F.R.L.

A67-36851
EFFECT OF MODE BEATING IN LASER-PRODUCED GAS BREAKDOWN.
David C. Smith and Richard G. Tomlinson (United Aircraft Corp., United Aircraft Research Laboratories, East Hartford, Conn.).
Applied Physics Letters, vol. 11, Aug. 1, 1967, p. 73-75. 9 refs.
ARPA-Navy-DOD-supported research.

Experiments have been carried out which show that the electrical breakdown of gases by optical frequency radiation is independent of the instantaneous intensity fluctuations arising from the interaction of modes present in laser radiation. Gas breakdown thresholds, determined with a single-mode ruby laser and a phase-locked neodymium laser, are in substantial agreement with published threshold data for conventional, multiple-mode laser radiation. It was thus determined that the breakdown threshold does not depend upon short term temporal and spatial fluctuations of the power density. (Author)

A67-36854
PASSIVE Q-SWITCHING OF A CO_2 LASER.
O. R. Wood and S. E. Schwarz (California, University, Dept. of Electrical Engineering and Dept. of Computer Sciences, Berkeley, Calif.).
Applied Physics Letters, vol. 11, Aug. 1, 1967, p. 88, 89. 5 refs.
Grant No. AF AFOSR 139-66/67.

Passive Q-switching of a CO_2-N_2-He laser has been obtained, using SF_6 gas as the saturable absorber. Peak power is 1 kw, in what appears to be a single transverse mode. This is 200 times the CW level for the same configuration and one-fifth that obtained with a mechanical Q switch. Pulse rates are in the range 10^3 to 10^4 pulses per sec. Operation is on a single vibrational-rotational line, unlike the case of CW operation. (Author)

A67-36855
BROAD-BAND LIGHT AMPLIFICATION IN ORGANIC DYES.
M. Bass and T. F. Deutsch (Raytheon Co., Research Div., Waltham, Mass.).
Applied Physics Letters, vol. 11, Aug. 1, 1967, p. 89-91. 11 refs.

Investigation of the use of two organic dyes previously used as liquid lasers (DTTC and cryptocyanine) as broad-band pulsed-light amplifiers in the 7000- to 8500-Å range. It was found that, if the input frequency is close to the frequencies of the usual laser oscillations, the latter are quenched and the energy is transferred to the frequency being amplified. M.M.

A67-36858
SIX DB/CM SINGLE-PASS GAIN AT 7229 Å IN LEAD VAPOR.
W. T. Silfvast and J. S. Deech (Oxford University, Dept. of Physics, Clarendon Laboratory, Oxford, England).
Applied Physics Letters, vol. 11, Aug. 1, 1967, p. 97-99.

A method has been developed to measure the single-pass gain of superradiant high-gain pulsed lasers by comparing the intensities of single-pass and double-pass radiation. This method is used on the 7229-Å transition in Pb I and gives a maximum single-pass gain of 63 db in a 10-cm effective length of lead vapor. The gain is confirmed by line-narrowing measurements and by power output measurements that are related to the theoretical intensities. (Author)

A67-36859
HIGH-GAIN LASER LINES IN NOBLE GASES.
O. Andrade, M. Gallardo, and K. Bockasten (Lund Institute of Technology, Lund, Sweden).
Applied Physics Letters, vol. 11, Aug. 1, 1967, p. 99, 100. 10 refs.
Research supported by the Swedish Natural Science Research Council.

Account of the observation of a number of lines of superradiant character in the near-IR wavelength region. Twenty-four superradiant lines from a pulsed discharge in neon, argon, krypton, and xenon were observed in the wavelength region from 8000 to 29,000 Å. All the lines have been classified as transitions in the neutral spectra. The upper levels are expected to be populated by electron impact or by cascade processes. M.M.

A67-36860 *
AN EXCITATION MECHANISM FOR THE A^+ LASER.
Said H. Koozekanani (Ohio State University, Dept. of Electrical Engineering, ElectroScience Laboratory, Columbus, Ohio).
Applied Physics Letters, vol. 11, Aug. 1, 1967, p. 107, 108. 11 refs.
Grant No. NsG-74-60.

Comparison of direct excitation from the metastable $3p^5$-4s state of A I to $3p^4$-4p upper laser state of A II with the two-step excitation from the same metastable state. It was found that, if the assumptions of the method of sudden perturbation are correct, just taking away the loosely bound 4s electron from the argon atom results in having a $|3p^4$-4p> configuration with a quite large cross section. Experimentally, this method cannot be distinguished from the case measured by Bennett, et al. when the p^6 atomic ground state loses one of its electrons and assumes $3p^4$-4p excited ionic state, since both processes give identical excited states. M.M.

A67-36999
ELECTRON INTERFERENCE EFFECTS INDUCED BY LASER LIGHT
John F. Dawson and Zoltan Fried (Lowell Technological Institute, Lowell, Mass.).
Physical Review Letters, vol. 19, Aug. 21, 1967, p. 467-469. 8 refs.
Army-supported research.

Outline of an electron-interference experiment involving laser light. The change in the phase of the electron wave function, which is accumulated throughout the time of passage of the electron through the laser beam, is compared with another (coherent) wave function which propagates outside the electromagnetic field. The electron wave function is split into two amplitudes, the first passing through the laser light and the second through the field-free region. It is concluded that presently available CW laser light sources can yield detectable "fringe" displacement in the electron interference pattern. Although interference experiments with electrons are more difficult than scattering experiments (such as the Kapitza-Dirac effect), the proposed scheme has the advantage of requiring much smaller intensities. B.B.

A67-37023
SCINTILLATION OF A GROUND-TO-SPACE LASER ILLUMINATOR.
D. L. Fried (North American Aviation, Inc., Autonetics Div., Electro-Optical Laboratory, Anaheim, Calif.).
Optical Society of America, Journal, vol. 57, Aug. 1967, p. 980-983. 8 refs.

The problem of scintillation of a laser beam because of atmospheric turbulence, which has previously been studied for a horizontal propagation path, is studied in this paper for a path from a ground-based transmitter to a measurement point in space. The results are presented in terms of the log-amplitude variance $C_\ell(0)$, from which the intensity variance can be computed. The log-amplitude variance is found to be separable into a strength factor $C_\ell^s(0)$ associated with the use of a zero-diameter source, and an aperture factor which measures the reduction of $C_\ell(0)$ caused by use of a large-aperture transmitter. Values of the aperture factor are calculated. (Author)

A67-37024
MODES OF A FABRY-PEROT LASER RESONATOR WITH OUTPUT-COUPLING APERTURES.
Tingye Li and H. Zucker (Bell Telephone Laboratories, Inc., Holmdel and Whippany, N.J.).
Optical Society of America, Journal, vol. 57, Aug. 1967, p. 984-986. 8 refs.

The modes and the eigenvalues are computed for a symmetric cylindrical Fabry-Pérot resonator with circular output-coupling apertures at the centers of the parallel-plane circular mirrors. Two approaches are used for the computation; the first involves a modification of the open-resonator theory of Vainshtein and the second involves the iterative solution of the integral equation. The computed results from these two different approaches are found to be in good agreement. (Author)

A67-37106
THE RADIATIVE BAND PINCH EFFECT AND TEMPERATURE DEPENDENCE OF RADIATIVE RECOMBINATION IN GaAs.
N. N. Winogradoff, K. Owen (National Bureau of Standards, Washington, D.C.), and R. M. Curnutt (U.S. Army, Materiel Command, Harry Diamond Laboratories, Washington, D.C.).
International Journal of Electronics, First Series, vol. 22, Mar. 1967, p. 229-233. 13 refs.

Observation that localized heating of GaAs by intense ruby laser flashes causes a reduction or "pinching" of the band gap in the illuminated region. The increase in wavelength of the recombination radiation from this region permits the study of the temperature dependence of the internal quantum efficiency without absorption in the colder wide band-gap regions. The results show that the internal quantum efficiency decreases with an increase in temperature. M.F.

A67-37146 #
THERMAL EFFECTS DURING INTERACTION OF A RUBY-LASER BEAM WITH "TRANSPARENT" CRYSTALS [PRO TEPLOVI EFEKTI PRI VZAEMODII PUCHKA RUBINOVOGO LAZERA Z "PROZORIMI" KRISTALAMI].
V. M. Vatul'ov and A. M. Kamuz (Akademiia Nauk Ukrains'koi RSR, Institut Fiziki, Kiev, Ukrainian SSR).
Ukrains'kii Fizichnii Zhurnal, vol. 12, July 1967, p. 1200-1202. 5 refs. In Ukrainian.

Experimental investigation of thermal processes within crystals subjected to a focused beam from a ruby laser. Spectroscopic observations were conducted with CdS, ZnS, CdS-CdSe, and GaSe crystals. The experimental apparatus was arranged to allow observation of the crystals throughout the entire pulse duration. Results are given for variations in the interference bands and absorption edge of the crystals during the duration of the laser pulse. The results are discussed in terms of the relationship between the spectral variations and thermal processes occurring in the crystals. T.M.

A67-37149 #
DEVICE FOR INVESTIGATING THE STABILITY OF A LASER OPERATING IN THE PERIODIC MODE [USTANOVKA DLIA ISSLEDOVANIIA STABIL'NOSTI OPTICHESKOGO KVANTOVOGO GENERATORA, RABOTAIUSHCHEGO V PERIODICHESKOM REZHIME].
V. P. Veiko, M. N. Libenson, and G. P. Suslov (Leningradskii Institut Tochnoi Mekhaniki i Optiki, Leningrad, USSR).
Priborostroenie, vol. 10, no. 6, 1967, p. 13-16. In Russian.

Description of a device for the automatic recording of laser emission and of the energy of the pumping pulse. The energy vs time is plotted to make it possible to assess the stability of the energy and angular characteristics of the laser emission and to study the effect that various factors (such as the instability of the power supply unit of the pumping lamp and the thermal system of the laser) have on the laser emission. P.v.T.

A67-37182
QUANTUMMECHANICAL SOLUTIONS OF THE LASER MASTER-EQUATION. II.
W. Weidlich, H. Risken, and H. Haken (Stuttgart, Technische Hochschule, Institut für theoretische Physik, Stuttgart, West Germany).
Zeitschrift für Physik, vol. 204, no. 3, 1967, p. 223-239. 17 refs.

A Fokker-Planck equation for a distribution function over the macroscopic observables of the laser essentially equivalent to that recently obtained by Risken, Schmid, and Weidlich is derived from the fundamental quantum-mechanical laser master equation. The general method used is the expansion of the statistical operator in a complete set of projection operators of the atoms and the light field. The assumptions leading from the microscopic equation of motion to the macroscopic semiclassical Fokker-Planck equation are explicitly introduced and discussed. (Author)

A67-37183
THE TRANSIENT SOLUTION OF THE LASER FOKKER-PLANCK EQUATION.
H. Risken and H. D. Vollmer (Stuttgart, Technische Hochschule, Institut für theoretische Physik, Stuttgart, West Germany).
Zeitschrift für Physik, vol. 204, no. 3, 1967, p. 240-253. 18 refs.

The transient solution of the laser Fokker-Planck equation is investigated in the threshold region. Especially for the initial condition (that no photons are present at $t = 0$), the transients of the laser distribution function, of the mean intensity, and of the mean squared deviation (variance) into the stationary values are shown. A physical explanation is given of the effects involved, and some features of the transient photon counting probability are discussed. (Author)

A67-37184
THEORY OF NOISE IN SEMICONDUCTOR LASER EMISSION.
H. Haug and H. Haken (Stuttgart, Technische Hochschule, Institut für theoretische Physik, Stuttgart, West Germany).
Zeitschrift für Physik, vol. 204, no. 3, 1967, p. 262-275. 11 refs.
Research supported by the Deutsche Forschungsgemeinschaft.

For the complex light field amplitude of a semiconductor laser an equation of a generalized van der Pol oscillator with a fluctuating driving term is derived from first principles. This equation is shown to be valid for optical band-to-band transitions with and without k-selection rule. Neglecting the nonlinearity in the saturation higher than second order and the intensity dependence of the dispersion, this equation reduces to the standard van der Pol equation with a noisy driving term. From the general equation the line width and the noise of the intensity of the laser emission are calculated above and below threshold. The results are in agreement with the experimental data of Armstrong and Smith. (Author)

A67-37185
THE REFLECTION OF ELECTRONS FROM STANDING LIGHT WAVES.
Helmut Schwarz (Rensselaer Polytechnic Institute of Connecticut, Inc., Hartford Graduate Center, East Windsor Hill, Conn.).
Zeitschrift für Physik, vol. 204, no. 3, 1967, p. 276-289. 14 refs.
Research supported by the Hartford Foundation for Public Giving and the Connecticut Research Commission.

Experiments are described in which a slow electron beam is deflected by a standing light wave produced by a high intensity laser. This interaction is believed to occur as a Bragg reflection of the electrons in the standing wave intensity pattern set up in the light beam, as predicted by Kapitza and Dirac (1933). No energy interchange takes place except a momentum transfer which results in a Bragg relationship for the angle of reflection. The probability is proportional to the square of the light intensity. Kapitza and Dirac's original particle treatment of the effect is shortly reviewed, and a wave mechanical treatment is added. Two experiments are described: in one an electron beam is scanned through a standing light wave, and any deflection is detected with a differential amplifier, while in the other the electron beam is locked in at maximum deflection, and the laser output is simultaneously displayed with the deflected electrons on a fast dual beam oscilloscope. The electron beam deflections follow the fine structure of the laser spikes. Results from both experiments stay within the right magnitude of the theoretical predictions. (Author)

A67-37276
CARBON DIOXIDE LASER HAZARDS TO THE EYE.
K. Gullberg, B. Hartmann (Research Institute of National Defence, Dept. of Physics, Stockholm, Sweden), E. Kock (Karolinska Sjukhuset, Stockholm, Sweden), and B. Tengroth (Göteborg, University, Sahlgren Hospital, Dept. of Ophthalmology, Göteborg, Sweden).
Nature, vol. 215, Aug. 19, 1967, p. 857, 858.

Study of the hazards to eyes from CO_2 laser IR radiation ($\lambda = 10.6$ μm), using rabbits as the test animals. The absolute power/unit area at the position of the rabbit's eye is checked calorimetrically between exposures. It is concluded that the radiation from CO_2 lasers is dangerous to the human eye, because even low-power radiation can cause irreversible changes in the cornea, leading to impaired vision. B.B.

A67-37289 * #
PHOTON BUNCHING IN A LASER AT THRESHOLD.
R. F. Chang, R. W. Detenbeck, V. Korenman, C. O. Alley, Jr. (Maryland, University, Dept. of Physics and Astronomy, College Park, Md.), and U. Hochuli (Maryland, University, Dept. of Electrical Engineering, College Park, Md.).
Physics Letters, vol. 25A, Aug. 14, 1967, p. 272, 273. 15 refs.
ARPA Contract No. SD-101; Contracts No. DAHC04-67-C-0023; No. Nonr-595(11); Grants No. NGR-21-002-022; No. NsG-398.

Description of the measurement of the second, third, and fourth cumulants of the intensity distribution of the light from a single-mode He-Ne laser operating at the oscillation threshold. The results of the measurements are found to agree with predictions of nonlinear oscillation theory over the region from one-tenth to ten times the threshold intensity. Values indicating the normalized cumulants of the distribution of intensity of laser light are plotted as functions of the ratio of mean to threshold intensity. B.B.

A67-37290 #
A SYSTEM FOR CONTINUOUS HIGH EFFICIENCY PUMPING OF CRYSTAL LASER RODS.
M. J. Taylor, A. M. White, and I. W. Mackintosh (Ministry of Technology, Royal Radar Establishment, Great Malvern, Worcs., England).
Physics Letters, vol. 25A, Aug. 14, 1967, p. 275-277.

Discussion of the possibility of achieving a considerable increase in the efficiency of facilities for high efficiency pumping of crystal laser rods by appropriate design of the pumping system, with particular attention to devices capable of CW output. It is found that by reducing the loss of pumping radiation from such an optically pumped laser system and causing unused radiation to be reabsorbed by the emitting source, its efficiency can be increased tenfold. B.B.

A67-37292 #
THE INTERACTION OF THE ULTRA-VIOLET AND NEAR INFRARED LASER SYSTEMS OF MOLECULAR NITROGEN.
L. Allen, D. G. C. Jones, and B. M. Sivaram (Sussex, University School of Mathematical and Physical Sciences, Brighton, England).
Physics Letters, vol. 25A, Aug. 14, 1967, p. 280, 281. 6 refs.
Research supported by the Ministry of Defence.

Analysis of the interaction between the nitrogen 1st + ve and 2nd + ve system of bands in a molecular-nitrogen laser, when they oscillate simultaneously in the UV and near IR. At a pressure of 2.5 torr, only the 1st + ve system lased for currents between 3 and 50 amp, while in the 50 to 1 amp range, both the 1st + ve and 2nd + ve systems were made to function. In the 100 to 160 amp range the 2nd + ve system continued to oscillate and grow in intensity. In the final range, super-radiance rather than laser action was found to occur in the UV when only one mirror was used. B.B.

A67-37295 #
INTENSITY DEPENDENCE OF EMISSION LINES IN CdS UPON EXCITATION INTENSITY (LASER) AT VERY LOW TEMPERATURE.
A. Mysyrowicz, J. B. Grun, A. Bivas, R. Levy, and S. Nikitine (Strasbourg, Université, Institut de Physique, Laboratoire de Spectroscopie et d'Optique du Corps Solide, Strasbourg, France).
Physics Letters, vol. 25A, Aug. 14, 1967, p. 286, 287.

The dependence of the emission intensity upon excitation intensity in a laser is reported for free exciton recombination (A_1) and for phonon-assisted free exciton recombination (A_1-LO) in CdS at 4.2°K. For an excitation intensity threshold, A_1 becomes sublinear, A_1-LO superlinear. (Author)

A67-37328 #
REFLEX MULTI-CAVITY SOLID-STATE MASERS CONTAINING THE ACTIVE MATERIAL IN ALL THE CAVITIES.
M. E. Zhabotinskii and A. V. Frantsesson.
(Radiotekhnika i Elektronika, vol. 12, Jan. 1967, p. 56-62.)
Radio Engineering and Electronic Physics, vol. 12, Jan. 1967, p. 48-53. 8 refs. Translation.

The bandwidths of reflex-type solid-state masers are increased by providing multicavity systems with active material in all the cavities. The approximation of uniform negative losses gives (by contour integration) an estimate of the bandwidth of such systems. The special case of a three-cavity maser is examined theoretically and experimentally, and it is shown that in the region of decimeter wavelengths (21 cm), this maser has a bandwidth larger than that of a traveling-wave maser. (Author)

A67-37329 #
A THREE-CAVITY SOLID-STATE MASER AT A WAVELENGTH OF 21 CM.
M. E. Zhabotinskii and A. V. Frantsesson.
(Radiotekhnika i Elektronika, vol. 12, Jan. 1967, p. 63-66.)
Radio Engineering and Electronic Physics, vol. 12, Jan. 1967, p. 54-57. Translation.

The three-cavity solid-state ruby maser operates at a temperature of 4.2°K and has a bandwidth of 18 MHz with a gain of 20 db. The small-size cavity system is formed by three closely spaced quarter-wave strips. The size of the three-cavity system differs only a little from the size of a single cavity. A permanent magnet is fixed directly to the cavity. With a cryostat capacity of 5 liters, the maser can operate for over 72 hours without replenishing the liquid helium. (Author)

A67-37338 #
KASTLER PHOTON ENSEMBLE AND THE STATISTICAL PROPERTIES OF LASER RADIATION IN MULTIMODE EXCITATION OPERATION.
V. V. Karavaev.
(Radiotekhnika i Elektronika, vol. 12, Jan. 1967, p. 144-146.)
Radio Engineering and Electronic Physics, vol. 12, Jan. 1967, p. 133-136. Translation.

A67-37340 #
EFFECT OF AN AXIAL MAGNETIC FIELD ON THE OUTPUT POWER OF A NEON-HELIUM LASER SIMULTANEOUSLY GENERATING LINES OF 3.39 AND 0.6328 MICRONS.
A. A. Kuznetsov, D. I. Mash, and N. V. Skuratova.
(Radiotekhnika i Elektronika, vol. 12, Jan. 1967, p. 150-153.)
Radio Engineering and Electronic Physics, vol. 12, Jan. 1967, p. 140-143. Translation.

A67-37547 #
SOLID-STATE LASERS [TVERDOTEL'NYE OPTICHESKIE KVANTOVYE GENERATORY].
A. A. Mak, Iu. A. Anan'ev, and B. A. Ermakov.
Uspekhi Fizicheskikh Nauk, vol. 92, July 1967, p. 373-426. 300 refs. In Russian.

Survey of the current theory and technology of solid-state lasers. A theoretical analysis of laser operation is made, and various design methods are discussed. The component elements of lasers are examined including the active media, pumping sources, illuminators, and valves in connection with their influence on laser operation. Experimental results concerning the energy, spectrum, space, and time-dependent characteristics of solid-state laser radiation are discussed and compared with current theoretical concepts. Methods of selecting axial and angular types of vibration are investigated together with methods for shortening the pulse duration. Various factors determining the limiting parameters of solid-state laser operation are described. T. M.

A67-37559 #
ACCURACY OF THE DETERMINATION OF THE POSITIONS OF THE LINES IN THE SPECTRA OF ATMOSPHERIC GASES FOR ESTIMATING THE ABSORPTION OF LASER RADIATION IN THE ATMOSPHERE [O TOCHNOSTI OPREDELENIIA POLOZHENIIA LINII V SPEKTRAKH ATMOSFERNYKH GAZOV DLIA OTSENKI POGLOSHCHENIIA IZLUCHENII LAZEROV V ATMOSFERE].

V. E. Zuev (Tomskii Gosudarstvennyi Universitet, Sibirskii Fiziko-Tekhnicheskii Institut, Tomsk, USSR).
Fizika, vol. 10, no. 3, 1967, p. 138-140. In Russian.

Analysis showing that in the case where monochromatic laser radiation appears in the central portion of the absorption line of water vapor, estimation of the monochromatic absorption coefficient requires (in addition to the exact value of the frequency of laser radiation) exact knowledge of the position of the center of the absorption line. The available spectrum charts contain highly inaccurate values of the position of the centers of lines, and should be treated with great caution. V.P.

A67-37564
HYDROFLUORIC ACID CHEMICAL LASER.
Karl L. Kompa and George C. Pimentel (California, University, Chemistry Dept., Berkeley, Calif.).
Journal of Chemical Physics, vol. 47, July 15, 1967, p. 857, 858.
USAF-supported research.

Experimental investigation of the use of hydrofluoric acid (HF) for chemical laser emission. Vibration-rotation laser emission has been observed between 2.76 and 2.91 μ and between 3.67 and 3.89 μ, respectively, in a few $2 \rightarrow 1P$ branch transitions of hydrogen fluoride and $2 \rightarrow 1$ and $3 \rightarrow 2$ transitions of deuterium fluoride formed in the flash photolysis of uranium hexafluoride in the presence of hydrogen and deuterium. HF is a particularly good prospect for chemical laser emission. Many reactions that produce HF are quite exothermic and HF has a low moment of inertia, so rotational dilution is minimized. The only obstacle is the danger of chemical attack on the laser tube. M.F.

A67-37591
GAS LASER IN A MAGNETIC FIELD.
M. I. D'iakonov and S. A. Fridrikhov (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut; Leningradskii Politekhnicheskii Institut, Leningrad, USSR).
(Uspekhi Fizicheskikh Nauk, vol. 90, Dec. 1966, p. 565-600.)
Soviet Physics - Uspekhi, vol. 9, May-June 1967, p. 837-859.
89 refs. Translation.

A67-37606 #
EXPERIMENTAL INVESTIGATION OF THE ABSORPTION OF THE EMISSION FROM A 1.15-μ GAS LASER IN THE ATMOSPHERE [EKSPERIMENTAL'NOE ISSLEDOVANIE POGLOSHCHENIIA IZLUCHENIIA GAZOVOGO LAZERA S DLINOI VOLNY 1,15 MK V ATMOSFERE].
B. A. Antipov, V. E. Zuev, and V. A. Sapozhnikova (Tomskii Gosudarstvennyi Universitet, Sibirskii Fiziko-Tekhnicheskii Institut, Tomsk, USSR).
Fizika, vol. 10, no. 6, 1967, p. 158-160. In Russian.

Laboratory investigation of the absorption of atmospheric gases near the laser emission lines in a vacuum multiple-pass cell. The use of this technique makes it possible to obtain absorption data that are free of the influence of aerosol scattering, which cannot be avoided under natural conditions. The equipment and procedure used in the experiments are described, and a block diagram of the equipment is included. The dependence of the signal logarithm on the pressure is diagramed for a path length of 95 m. V. P.

A67-37668 #
EXPERIMENTAL INVESTIGATION OF THE ABSORPTION OF THE RADIATION OF GAS LASERS WITH WAVELENGTHS OF 3.39 AND 3.51 μ IN THE ATMOSPHERE [EKSPERIMENTAL'NOE ISSLEDOVANIE POGLOSHCHENIIA IZLUCHENIIA GAZOVYKH LAZEROV S DLINAMI VOLN 3,39 I 3,51 MKM V ATMOSFERE].
B. A. Antipov, V. E. Zuev, and V. A. Sapozhnikova (Tomskii Gosudarstvennyi Universitet, Sibirskii Fiziko-Tekhnicheskii Institut, Tomsk, USSR).
Fizika, vol. 10, no. 7, 1967, p. 142-144. In Russian.

Experimental investigation of the atmospheric absorption of gas-laser radiation at wavelengths of 3.39 and 3.51 μ. The experiments involved measurements of radiation intensity in relation to the degree of gas pressure in the beam's path. Air at pressures from 1 mm Hg to atmospheric pressure was used together with various partial pressures of methane. Results are given for the dependence of absorption at both wavelengths on the gas pressure and the amount of methane. T.M.

A67-37854
THE USE OF A MULTIPATH CELL AS A CO_2-N GAS LASER AMPLIFIER AND OSCILLATOR.
George J. Dezenberg and James A. Merritt (U.S. Army, Missile Command, Redstone Arsenal, Ala.).
Applied Optics, vol. 6, Sept. 1967, p. 1541-1543.

Description of a multipath cell using a modified White mirror system which has been operated as an amplifier and as an oscillator at the 10.6-μ CO_2 transition of the CO_2-N_2 gas laser. An oscillator tube efficiency of 33% and an amplifier power gain of 8.7 have been obtained. With a specific gas mixture, the amplifier saturated output power is approximately one-half that of the maximum oscillator output. M.M.

A67-37855
VIBRATIONAL ENERGY LEVEL POPULATION IN OPTICALLY PUMPED AgCl VAPOR.
L. Allen and D. G. C. Jones (Sussex, University, School of Mathematical and Physical Sciences, Brighton, England).
Applied Optics, vol. 6, Sept. 1967, p. 1545-1548. 14 refs.
Research supported by the Ministry of Defence.

A process is discussed which could lead to laser oscillation in the UV, employing vibrational energy levels in different electronic states of a diatomic molecule. A pulse from a Lyman discharge tube is passed through AgCl vapor. Absorption and subsequent fluorescence occur, and analysis of the resulting output pulse, together with previously measured values of the lifetimes involved, enable the populations of eight vibrational energy levels to be computed. No inversion is found to occur between the two electronic states but inversions 5×10^9 mol/cm^3 are found to occur between pairs of vibrational levels in the same electronic state. (Author)

A67-37857
INCREASING PUMP FLUX OF LASERS BY IMMERSION.
K. Tomiyasu (General Electric Co., Research and Development Center, Schenectady, N.Y.).
Applied Optics, vol. 6, Sept. 1967, p. 1578, 1579. 5 refs.

Discussion of the effect due to immersion on concentrating and increasing the pump flux of a laser incident on an absorbing core. Two configurations are considered; an infinitely long transparent rod of radius R and index n, surrounded by an isotropic diffuse radiation source radiating into 2π steradians with a Lambertian distribution, and an infinitely long, infinitesimally wide longitudinal strip on a cylindrical surface. R.B.S.

A67-37858 *
CONTINUOUS WAVE LASER GROUND-TO-SPACE-TO-GROUND LASER EXPERIMENT.
K. Lang and R. Lucy (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Applied Research Laboratory, Waltham, Mass.).
Applied Optics, vol. 6, Sept. 1967, p. 1579.
NASA-sponsored research.

Brief description of a CW-laser ground-to-space-to-ground experiment carried out in conjunction with the tracking of the Explorer 22 satellite. Experiment parameters and the passive tracking record of the satellite are given. It is concluded that if a scintillation experiment were to be performed, the system would require improvements of a factor of 10^2 to 10^3, which could be in the form of greater transmitter power, a larger collecting aperture, reduced skyglow, reduced aerosol backscatter, and possibly the application of cooled photomultipliers. R.B.S.

A67-37864 #
THEORY OF COUPLED OPEN RESONATORS [DO TEORII ZV'IAZANIKH VIDKRITIKH REZONATORIV].
E. P. Kurushin and E. I. Nefedov (Akademiia Nauk SSSR, Institut Radiotekhniki i Elektroniki, Moscow, USSR).
Ukrains'kii Fizichnii Zhurnal, vol. 12, June 1967, p. 954-959.
11 refs. In Ukrainian.

Description of a method for analytically representing the diffraction coefficient of open laser resonators coupled in series. The theoretical substantiation of this method is discussed in detail for various boundary conditions. V. Z.

A67-37867 #
KINETIC ASPECTS OF INDUCED THREE-PHOTON COMBINATION SCATTERING [DO PITANNIA PRO KINETIKU INDUKOVANOGO TRIFOTONNOGO KOMBINATSIINOGO ROZSIIUVANNIA].
I. O. Marushko and V. S. Mashkevich (Akademiia Nauk Ukrains'koi RSR, Institut Fiziki, Kiev, Ukrainian SSR).
Ukrains'kii Fizichnii Zhurnal, vol. 12, June 1967, p. 1032-1034. 6 refs. In Ukrainian.

Note on the kinetics of three-photon combination scattering as applied to laser pumping. The theoretical aspects and practical value of this technique are discussed briefly. V. Z.

A67-37940
ELECTRON ENERGY DISTRIBUTION IN A NEON-HYDROGEN MIXTURE IN A HOLLOW-CATHODE DISCHARGE.
V. L. Afanas'eva, A. V. Lukin, and K. S. Mustafin.
(Zhurnal Tekhnicheskoi Fiziki, vol. 37, Feb. 1967, p. 327-329.)
Soviet Physics - Technical Physics, vol. 12, Aug. 1967, p. 233-235. 6 refs. Translation.

Outline of the Fabrikant method for achieving population inversion in lasers by depleting the lower level of the working transition by using quenching impurities. The energy distribution functions f(ev) in pure Ne and in a Ne + H_2 mixture in a hollow-cathode discharge are investigated. The function f(ev) was determined by Druyvesteyn's formula. Measurements indicate that in the Ne + H_2 mixture the relative number of fast electrons increased with current. Curves showing the energy distribution in pure Ne and mixture and a table illustrating the concentration of excited atoms on Ne levels are given. The results of the investigation show that an addition of H_2 to Ne leads both to a quenching of metastables of Ne and to a considerable change in the energy distribution shape. A. B.

A67-37941
OUTPUT PULSATIONS IN A MASER.
N. G. Basov, V. N. Morozov, and A. N. Oraevskii (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Zhurnal Tekhnicheskoi Fiziki, vol. 37, Feb. 1967, p. 335-338.)
Soviet Physics - Technical Physics, vol. 12, Aug. 1967, p. 240-242. 10 refs. Translation.

Investigation of a maser in which the number of active particles entering the resonator is varied by means of electrical or magnetic fields. The instability of the monochromatic oscillation of a maser when the pump power exceeds the threshold value is ascertained. Maser equations for the case in which the initial number of active particles varies in time are derived. It is shown that sustained fluctuations of the radiation intensity can be excited in such a system and that the modulation depth and repetition rate of the pulses are determined by the frequency at which the flux of active particles is modulated. Low relative variations of the number of active particles are necessary for the excitation of strongly modulated oscillations. A numerical example considering the condition of self-excitation in an ammonia maser with a resonator Q of 5×10^3 and a line Q of 2.5×10^6, is given. A. B.

A67-37942
THERMAL METHODS FOR LASER EXCITATION.
N. G. Basov, A. N. Oraevskii, and V. A. Shcheglov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Zhurnal Tekhnicheskoi Fiziki, vol. 37, Feb. 1967, p. 339-348.)
Soviet Physics - Technical Physics, vol. 12, Aug. 1967, p. 243-249. 11 refs. Translation.

Discussion of methods for rapid adiabatic cooling of gaseous systems for the purpose of obtaining states with population inversion. These methods are (1) rapid heating and cooling, (2) adiabatic cooling in a chemical shock tube, and (3) cooling by expansion through a nozzle or slit. Corresponding curves, diagrams, and vibrational level schemes in molecules are given. The feasibility of operating a laser in the infrared region by employing a molecular beam and properly choosing a suitable material for the thermal excitation is also discussed. A. B.

A67-37943
PROPERTIES OF INJECTION LASERS AT 0.8-1.1 μ.
N. G. Basov, P. G. Eliseev, I. Ismailov, I. Z. Pinsker, and V. P. Strakhov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Zhurnal Tekhnicheskoi Fiziki, vol. 37, Feb. 1967, p. 349-359.)
Soviet Physics - Technical Physics, vol. 12, Aug. 1967, p. 250-257. 11 refs. Translation.

Comparative investigation of injection lasers in the range 0.8 to 1.1 μ, directed toward a better understanding of their mechanisms and differences between them. A table of data showing the characteristics of various lasers is given. Investigation methods, threshold current densities, emission spectra, directivity and polarization of the emission, and power characteristics are discussed. It is concluded that (1) in the range 0.8 to 1.1 μ, $A^{III} B^{V}$ compound lasers behave in a similar manner, (2) the main difference between GaAs lasers and others with inferior characteristics is that the quantum characteristics of the others are less by a factor of 3 to 35, and (3) the threshold current densities of $A^{III} B^{V}$ compound lasers are correlated with the quantity Z derived from other laser characteristics. A. B.

A67-37945
CONSTRUCTION OF LASER-DIODE IMPULSE GENERATORS BY MEANS OF FOUR-LAYER DIODES AND THYRISTORS [AUFBAU VON LASERDIODEN-IMPULSGENERATOREN MITTELS VIERSCHICHTDIODEN UND THYRISTOREN].
H. Rieck (Aachen, Technische Hochschule, Institut für Halbleitertechnik, Aachen, West Germany) and P. Horn.
Internationale Elektronische Rundschau, vol. 21, June 1967, p. 135-138. 10 refs. In German.

Description of the structure of laser-diode impulse generators with ladder networks, four-layer diodes and thyristors. These generators supply short pulses of high current intensity to a low resistance load, consisting of a laser-diode with an ohmic resistance in series. The four-layer diodes have fast switching times (from 30 to 100 nsec) as well as admissible-pulse currents up to 20 amp. If the four-layer diode is replaced by a thyristor, a fully triggered discharge with a low loading capacity is obtained, and spike pulses appear with a duration of approximately 40 nsec at a current of 100 amp. P. v. T.

A67-38008
THE NONLINEAR THIRD ORDER DIELECTRIC SUSCEPTIBILITY COEFFICIENTS OF GASES AND OPTICAL THIRD HARMONIC GENERATION.
W. G. Rado (Ford Motor Co., Scientific Laboratory, Dearborn, Mich.).
Applied Physics Letters, vol. 11, Aug. 15, 1967, p. 123-125. 10 refs.

The nonresonant third order nonlinear dielectric susceptibility coefficients of several gases were measured in a four wave mixing experiment. These coefficients were used to calculate the amount of third harmonic radiation generated in gases in a focused laser beam. No signal distinguishable from noise was ever seen from gases, although more than 10^4 times the minimum detectable signal was predicted. (Author)

A67-38010
ASSESSMENT OF LITHIUM-META-NIOBATE FOR NONLINEAR OPTICS.
J. E. Midwinter (Ministry of Technology, Royal Radar Establishment, Great Malvern, Worcs., England).
Applied Physics Letters, vol. 11, Aug. 15, 1967, p. 128-130. 11 refs.

Techniques for evaluating the quality of single crystals of $LiNbO_3$ by a Twyman-Green interferometer and between crossed polarizers are described and the quality coefficients so obtained are compared with the second-harmonic generation performance measured using a 1.084-μ gas laser. The variations in quality are interpreted in terms of gradients of chemical composition, and a method for partially correcting them is described. (Author)

A67-38017
LASER INTERFEROMETRIC MEASUREMENTS OF ELECTRON DENSITY IN AN ARC PLASMA.

K. R. Hearne and N. Konjević (Liverpool, University, Dept. of Electrical Engineering and Electronics, Liverpool, England).
Zeitschrift für Physik, vol. 204, no. 5, 1967, p. 443-455. 28 refs.

The paper describes the application of a laser interferometric technique to arc discharges operating at atmospheric pressure. The limitations of this method are discussed in detail. Results are given for the axial electron density in an argon arc (tube diameter equals 5 mm) over a current range 30 to 75 amp. In addition the decay of the electron density following rapid arc interruption is also given. It is shown that the time constant of the conductance decay which can be derived from the preceeding measurements is in very good agreement with experimental values determined directly. (Author)

A67-38018

EFFECTIVE CROSS-SECTION OF DEPOLARIZED COLLISIONS OF EXCITED SODIUM ATOMS WITH NOBLE GAS ATOMS THROUGH OPTICAL PUMPING WITH D_2-LIGHT [WIRKUNGSQUERSCHNITTE DEPOLARISIERENDER STÖSSE VON ANGEREGTEN NATRIUM-ATOMEN MIT EDELGASATOMEN DURCH OPTISCHES PUMPEN MIT D_2-LICHT].
M. Elbel and F. Naumann (Marburg, Universität, Physikalisches Institut, Marburg an der Lahn, West Germany).
(Deutsche Physikalische Gesellschaft, Frühjahrstagung, Freudenstadt, West Germany, Apr. 6, 1967, Vortrag.)
Zeitschrift für Physik, vol. 204, no. 5, 1967, p. 501-513. 12 refs. In German.

Observation that optical pumping of sodium vapor with D_2-light causes an increase in optical transparency if complete collision-induced mixing takes place among the sublevels of the excited ^2P-states. It causes a decrease in optical transparency if there is no mixing in the excited states. It causes no change of optical transparency if excited-state mixing is as strong as the condition $2T = 3\tau$ predicts, T being the mean collision time, τ the mean life time of the excited states. The latter case can be realized by certain buffer gas pressures. These pressures have been measured for the gases helium, neon, and argon. From these pressure excited-state mixing cross sections have been deduced by means of the condition $2T = 3\tau$. Finally the "uniform" mixing model hitherto used has been critically revised. A more realistic model is proposed which ascribes excited-state mixing to scattering phase shifts between the molecular σ- and π-states into which the atomic ^2P-state splits during the collision. Nevertheless, the condition $2T = 3\tau$ is not seriously altered even in this refined model. M.F.

A67-38062

ADVANCES IN GAS LASERS.
Peter O. Clark (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.).
Electronic Communicator, vol. 2, July-Aug. 1967, p. 7. 5 refs.

Brief discussion of recent advances in the field of gas lasers. Regions of the frequency spectrum covered by molecular, ion, and neutral gas lasers are given, as well as elements which have demonstrated laser action as neutral atoms and as ions. Emphasis is given to the 10.6-μ CO_2 laser, which has produced CW powers in excess of 1 kw at efficiencies as high as 20%. R.B.S.

A67-38094

SELF-FOCUSING OF LASER BEAMS IN RUBY AND LEUCOSAPPHIRE CRYSTALS.
G. M. Zverev, T. N. Mikhailova, V. A. Pashkov, and N. M. Solov'eva.
(ZHETF Pis'ma v Redaktsiiu, vol. 5, June 1, 1967, p. 391-393.)
JETP Letters, vol. 5, June 1, 1967, p. 319-321. 11 refs. Translation.

Observation of self-focusing in ruby and leucosapphire crystals, with investigation of damage produced by light pulses at the frequencies of ruby and neodymium-glass lasers and their second harmonics. The ruby and neodymium-glass lasers damaged the crystals in the focal region of the lens. The damage consisted of flat cracks crossing along the beam axis. The second harmonics produced damage in the form of very thin and long filaments, usually emerging from the focus and directed along the laser beam axis. Such damage can be explained only by assuming self-focusing and self-trapping of the laser beams. F.R.L.

A67-38253 #

FAR-INFRARED AND SUBMILLIMETER MASER OSCILLATORS WITH H_2O AND D_2O.
Arimichi Minoh, Tadao Shimizu, Shunsuke Kobayashi, and Koichi Shimoda (Institute of Physical and Chemical Research, Microwave Physics Laboratory, Tokyo, Japan).
Japanese Journal of Applied Physics, vol. 6, Aug. 1967, p. 921-930. 7 refs.

The construction and operating characteristics of far-infrared masers with water and deuterium oxide are presented. The maser tube is 5 cm in inner diameter with internal mirrors separated by about 5 m. Concave spherical mirrors of 6 cm diameter are used. Under pulsed excitation of 5 to 10 kv (duration 40 μsec) through water vapor at about 0.2 torr, strong maser oscillations are obtained at 47.4, 78.4, 79.1, 118.7, 120.1 and 220 μ wavelengths in H_2O, and at 36.4, 72.7, 74.5, 84.3, 107.7 and 171.6 μ in D_2O. Output characteristics vs gas pressure, excitation voltage, and longitudinal magnetic field are shown. At the optimum operation with longitudinal magnetic fields, peak output powers at 118.7 and 171.6 μ are estimated to be as large as about 3 and 6 w, respectively. (Author)

A67-38256 #

CURRENT DEPENDENCE OF JUNCTION TEMPERATURE IN C-W OPERATED GaAs LASER DIODES.
Wataru Susaki (Mitsubishi Electric Corp., Kita-Hami Works, Hami, Hyogo, Japan).
Japanese Journal of Applied Physics, vol. 6, Aug. 1967, p. 977-981. 11 refs.

Observation that in a CW-operated laser diode, the junction temperature depends critically on the current because of the generation of heat. The current dependence of the junction temperature in GaAs laser diodes which were mounted on a heat sink is examined at a temperature of 77°K. An approximate steady-state equation of the heat flow is derived, taking into account the temperature dependence of the thermal conductivity of GaAs. Fairly good agreement with experiment is obtained. M.F.

A67-38259 #

DENSITY AND TEMPERATURE OF LASER-PRODUCED PLASMA IN A SPACE CHAMBER.
Motokazu Hirono and Iwao Iwamoto (Ministry of Posts and Telecommunications, Radio Research Laboratories, Tokyo, Japan).
Japanese Journal of Applied Physics, vol. 6, Aug. 1967, p. 1006.

Study of the characteristics of charged particles produced by irradiation of a focused giant pulse of about 1300 Mw/cm^2 on an aluminum target in the vacuum of a space chamber having a volume of about 1 m^3. The behavior of the plasma can be described not by the motion of a single particle in the electric or magnetic field, but by the unified motion of both charges connected by the electric field, as in the usual plasma hydrodynamics. It is pointed out that the conclusion by Namba et al. (1966) that only ions are produced by the laser beams should be reexamined. M.F.

A67-38261 #

QUENCHING RESPONSE ON A GaAs DUAL LASER.
Hiroo Yonezu, Akira Kawaji, and Yoshihiro Yasuoka (Nippon Electric Co., Ltd., Central Research Laboratories, Kawasaki, Japan).
Japanese Journal of Applied Physics, vol. 6, Aug. 1967, p. 1018.

Investigation of the delay time of quenching phenomena in gallium arsenide injection lasers. The response to quenching and the recovery from quenching at 77°K were measured. The detection of the laser beam was carried out by the use of avalanche photodiodes of two kinds whose time constants τ_c were 0.3 and 0.08 nsec for the 50-ohm load. The quenching and recovery responses for an avalanche photodiode with τ_c = 0.08 nsec were almost the same as those for τ_c = 0.3 nsec. M.F.

A67-38262 #

MEASUREMENT OF THERMAL DIFFUSIVITY BY LASER PULSE.
Susumu Namba, Pil Hyon Kim, Tsutomu Arai (Institute of Physical and Chemical Research, Tokyo, Japan), and Takeo Kikuchi (Japan Atomic Energy Research Institute, Ibaraki, Japan).
Japanese Journal of Applied Physics, vol. 6, Aug. 1967, p. 1019.

Measurement of the thermal diffusivity of a nickel sample, using a normal ruby laser as the pulse-energy source because of

its high intensity and small divergence. The relationship between the thermal diffusivity of 99.4% Ni and temperature is plotted. It is found that the thermal diffusivity decreases with increasing temperature up to ~320°C, which corresponds to the Curie point of the nickel, and increases with higher temperature. M. F.

A67-38353 #

CIRCULAR POLARIZATION IN A $j = 1 \rightarrow j = 0$ - TRANSITION LASER.

D. Polder and W. Van Haeringen (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands).

Physics Letters, vol. 25A, Aug. 28, 1967, p. 337, 338. 11 refs.

Comments on a prediction that the transitions $j \rightarrow j$ ($j > 1$) should demonstrate a tendency toward circular polarization of an isotropic laser, while the transitions $j = 0 \rightarrow j = 1$ and $j = 1 \rightarrow j = 1$ are expected to be neutral in this respect. The tendency for circular polarization of an isotropic laser involving a $j = 1 \rightarrow j = 0$ transition is caused by the difference between the relaxation rates of the quadrupole moment and the angular momentum in the degenerate level. B. B.

A67-38355 #

DYNAMICS OF THE LASER RADIATION AT THRESHOLD.

F. T. Arecchi, M. Giglio, and A. Sona (Centro Informazioni Studi Esperienze, Laboratori; Milano, Università, Milan, Italy).

Physics Letters, vol. 25A, Aug. 28, 1967, p. 341, 342. 8 refs.
Research supported by the Consiglio Nazionale delle Ricerche.

Spectral analysis of the intensity fluctuations of a laser at threshold. The experimental results confirm the time resolution of the intensity correlation, as described by the nonlinear theory of the oscillator in terms of a weighted sum of exponentials. B. B.

A67-38367

ANGULAR DIVERGENCE OF SOLID STATE LASER RADIATION.

Iu. A. Anan'ev, A. A. Mak, and B. M. Sedov.

(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, Jan. 1967, p. 12-20.)
Soviet Physics - JETP, vol. 25, July 1967, p. 6-11. 20 refs.
Translation.

The angular divergence of radiation from neodymium glass and $CaF_2:Sm^{2+}$ lasers is studied for the case of variable resonator and pump parameters. It is shown that angular divergence in homogeneous active media is determined by spatial competition between the transverse resonator modes. Appropriate mode selection can reduce the angular divergence down to the diffraction limit without a significant drop in the output power. (Author)

A67-38370

INVESTIGATIONS OF NEW CRYSTALS FOR Q-SWITCHED LASERS.

A. A. Kaminskii and V. N. Shpakov (Akademiia Nauk SSSR, Institut Kristallografii, Moscow, USSR).

(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, Jan. 1967, p. 103-111.)
Soviet Physics - JETP, vol. 25, July 1967, p. 67-71. 22 refs.
Translation.

The results are reported of spectroscopic investigations of the emission at 300°K, under free generation and Q-switching conditions, of lasers made of CaF_2-Nd^{3+} type I and type II, CaF_2-YF_3-Nd^{3+}, CaF_2-CeF_3-Nd^{3+}, BaF_2-LaF_3-Nd^{3+}, SrF_2-LaF_3-Nd^{3+}, $CaWO_4$-Nd^{3+} and $Y_3Al_5O_{12}$-Nd^{3+} crystals, and of KGSS-7 glass. A block diagram of the apparatus used is shown. (Author)

A67-38373

DYNAMICS OF GENERATION OF GIANT COHERENT LIGHT PULSES. II.

V. S. Letokhov and A. F. Suchkov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).

(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, Jan. 1967, p. 282-292.)
Soviet Physics - JETP, vol. 25, July 1967, p. 182-188. 10 refs.
Translation.

An investigation is made of the basic phases of development of giant pulses of coherent light: the formation of the field distribution in the linear domain of generation and the dependence of the distribution on the random initial amplitudes of the electromagnetic field, the transverse development of the generation in the nonlinear domain. The effect of the inhomogeneity in the index of refraction of the medium inside the resonator on the dynamics of generation of giant pulses is investigated. (Author)

A67-38392

LASERS IN HIGH TEMPERATURE RESEARCH.

E. Bernal G. and J. F. Ready (Honeywell, Inc., Research Center, Hopkins, Minn.).

IN: INTERNATIONAL SYMPOSIUM ON HIGH TEMPERATURE TECHNOLOGY, 3RD, PACIFIC GROVE, CALIF., SEPTEMBER 17-20, 1967, ADVANCE PAPERS. [A67-38390 21-06]
Symposium sponsored by the Advanced Research Projects Agency, the Materials Laboratory of the U.S. Air Force, the U.S. Atomic Energy Commission, and NASA.
Menlo Park, Calif., Stanford Research Institute, 1967, p. 67-100. 37 refs.

Study of the applications in the technological and basic-research area of lasers in high-temperature research. Different types of lasers are described, and the advantages and disadvantages of these lasers with respect to producing high temperatures are presented. This is followed by some calculations of the heating of metals with lasers and a brief review of applications in welding and machining of solids. Particle emission from laser-irradiated surfaces is analyzed, and a brief description of research on the production of high-temperature plasma by the breakdown of gases and by the evaporation of small solid particles at the focus of a laser beam is given. R. B. S.

A67-38451 #

TEMPERATURE DEPENDENCE OF THE RADIATION FREQUENCY OF A RUBY LASER WITH A PHTHALOCYANINE BLOCKING DEVICE [O TEMPERATURNOI ZAVISIMOSTI CHASTOTY IZLUCHENIIA RUBINOVOGO OKG S FTALOTSIANINOVYM ZATVOROM].

V. A. Ivanov, V. I. Lebedev, and V. A. Pilipovich (Akademiia Nauk Belorusskoi SSR, Institut Fiziki, Minsk, Belorussian SSR).

Akademiia Nauk BSSR, Doklady, vol. 11, July 1967, p. 590-592. 7 refs. In Russian.

Experimental study of the temperature dependence of the radiation frequency of a ruby laser having pulsed Q-switching by a phthalocyanine blocking device in the temperature range from 10 to 40°C. The narrow spectral width of the radiation was observed, using a Fabry-Pérot interferometer. Results are given in terms of the radiation frequencies of the laser at various temperature values. It is demonstrated that the stability of the radiation frequency of the laser may be improved by including a mode selector in the resonator. The radiation spectrum of a laser with such a mode selector is examined in relation to temperature variation. T. M.

A67-38454

SOLID-STATE OPTICALLY PUMPED MICROWAVE MASERS.

Edward S. Sabisky and C. H. Anderson (Radio Corporation of America, RCA Laboratories, David Sarnoff Research Center, Electronic Research Laboratory, Princeton, N. J.).

IEEE Journal of Quantum Electronics, vol. QE-3, July 1967, p. 287-295. 15 refs.
Research supported by the Radio Corporation of America and DOD.

Optically pumped, CW microwave masers were successfully demonstrated using CaF_2 and SrF_2 doped with divalent thulium as the impurity ion. The optical pumping method made use of the polarization properties of the broad absorption bands of Tm^{2+} to selectively pump the ground state maser levels. Cavity masers were operated as oscillators at 1.4°K at frequencies from 9.2 to 18 GHz and at 9.2 GHz for temperatures of 4.2°K. The figure-of-merit of this material based on the gain bandwidth product is equivalent to that of the conventional maser materials, ruby and $Cr^{3+}(Fe^{3+})$ in rutile, at 10 GHz and 4.2°K but has a higher figure-of-merit above 10 GHz. This material can be used to make CW masers up to about 30 GHz. The limitation on tunability of this type of maser is restricted to the microwave circuit since no tuning of the pump frequency is required. The upper operating temperature based on reasonable pump powers is, for intrinsic reasons, 6°K.

For higher operating temperatures or higher signal frequencies at helium temperatures, a new material must be found having properties similar to the F center in the alkali halides but being more stable and in a more desirable host. (Author)

A67-38455
LASER BIBLIOGRAPHY V.
Kiyo Tomiyasu (General Electric Co., Research and Development Center, Schenectady, N.Y.).
IEEE Journal of Quantum Electronics, vol. QE-3, July 1967, p. 296-329.

Laser bibliography compiled during the period from July through December 1966 and containing 809 references which are divided into 27 categories and listed chronologically. The main subject categories include: different types of lasers; giant-pulse techniques; coherence, interference, quantum noise, narrow-line-width lasers, and frequency control; Raman and Brillouin scattering; harmonic generation; nonlinear, thermal, and interaction effects with matter; transmission, propagation, scattering, reflection, and filtering; and holography and wavefront reconstruction. M.F.

A67-38457
THRESHOLD CURRENT DENSITY IN SOLUTION-GROWN GaAs LASER DIODES.
Wataru Susaki, Taiji Oku, and Toshio Sogo (Mitsubishi Electric Corp., Kita-Itami Works, Itami, Japan).
IEEE Journal of Quantum Electronics, vol. QE-3, July 1967, p. 332, 333. 8 refs.

Threshold current density of solution-grown GaAs laser diodes with a Fabry-Pérot cavity were measured at 77 and 300°K by varying the acceptor concentration in the p region N_a. Threshold current density was lower in the series of diodes with larger values of N_a than in the series of diodes with smaller values of N_a for the diode length between 0.1 and 1 mm. Through these experiments diodes with the threshold current density as low as 3×10^2 amp/cm^2 at 77°K and 2.8×10^4 amp/cm^2 at 300°K for the diode length of 1 mm, and as low as 10^3 amp/cm^2 at 77°K and 4.5×10^4 amp/cm^2 at 300°K for the diode length of 0.1 mm were obtained. (Author)

A67-38458
LASER EMISSION FROM ELECTRON BEAM EXCITED ZnTe.
C. E. Hurwitz (Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Mass.).
IEEE Journal of Quantum Electronics, vol. QE-3, July 1967, p. 333, 334. 7 refs.
USAF-supported research.

Description of experiments in which ZnTe lasers were produced by electron-beam excitation. A peak output power of 90 watts was obtained at liquid-helium temperature with 8% overall power efficiency at 5280 Å. Laser action at liquid-nitrogen temperature with an emission wavelength of 5310 Å was also observed at somewhat reduced levels of output power and efficiency. It is pointed out that the very high values of the laser-excitation threshold in ZnTe, compared with those observed in similarly excited CdS, are due in large part to the lower quality of the present bulk ZnTe crystals. M.F.

A67-38460
RAPID SCAN SPECTROMETER FOR CO_2 LASER STUDIES.
T. J. Bridges and A. R. Strnad (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
IEEE Journal of Quantum Electronics, vol. QE-3, July 1967, p. 335-337.

Observation that many molecular gas lasers will oscillate on a number of closely spaced lines in various branches of the vibrational-rotational spectrum of the molecule. Thermalizing collisions between molecules result in strong competition between the lines. In a typical CO_2 laser at 10.6-μ wavelength this competition limits the oscillation to about 8 or 10 or the stronger lines around P(20). The competition is also involved in time-dependent effects such as hysteresis and reactive Q switching. The rapid changes with time involved in some of these effects make it difficult to study them with an ordinary slow scanning spectrometer. This problem was solved by modifying an 83G Perkin Elmer spectrometer to give a repetitive rapid scan of about 1% of its operating wavelength. M.F.

A67-38461 *
ABSOLUTE FREQUENCY STABILIZATION OF A LASER OSCILLATOR AGAINST A LASER AMPLIFIER.
A. E. Siegman.
IEEE Journal of Quantum Electronics, vol. QE-3, July 1967, p. 337-339. 5 refs.
Research supported by Sylvania Electronic Systems Independent Research and Development Funds; Contract No. NAS 8-20631.

Discussion of the capabilities and potential advantages of a relatively straightforward stabilization scheme - namely, stabilizing the frequency of a laser oscillator against a separate reference laser amplifier of the same type. It is concluded that this discrimination scheme can have at least satisfactory sensitivity, combined with other potential advantages for practical laser systems. It would be susceptible to residual AM effects that may occur due to various causes in a high-level FM modulator. However, by turning off the reference laser amplifier, such AM effects can be directly measured and cancelled in various ways. M.F.

A67-38548
LASER MICHELSON INTERFEROMETER.
Iu. D. Kolomnikov, V. N. Lisitsyn, and V. P. Chebotaev.
(Optika i Spektroskopiia, vol. 22, May 1967, p. 828-831.)
Optics and Spectroscopy, vol. 22, May 1967, p. 449, 450. Translation.
[For abstract see issue 15, page 2486, Accession no. A67-29467]

A67-38549
ON PARAMAGNETIC RESONANCE IN THE NONLINEAR THEORY OF THE ZEEMAN EFFECT.
N. N. Rozanov.
(Optika i Spektroskopiia, vol. 22, May 1967, p. 831-834.)
Optics and Spectroscopy, vol. 22, May 1967, p. 450, 451. 11 refs. Translation.
[For abstract see issue 15, page 2498, Accession no. A67-29468]

A67-38550
LASER SUBJECT TO AN EXTERNAL SIGNAL.
R. F. Boikova and E. E. Fradkin.
(Optika i Spektroskopiia, vol. 22, May 1967, p. 834-837.)
Optics and Spectroscopy, vol. 22, May 1967, p. 452, 453. Translation.
[For abstract see issue 15, page 2498, Accession no. A67-29469]

A67-38594 #
EXPERIMENT CONCERNING THE OPERATION OF A MOLECULAR-BEAM LASER ON BOARD A SATELLITE [OPYT RABOTY MOLEKULIARNOGO GENERATORA NA ISKUSSTVENNOM SPUTNIKE ZEMLI].
N. G. Basov, M. I. Borisenko, V. P. Vlasov, S. P. Dubonosov, N. E. Ivanov, G. M. Strakhovskii, G. M. Fedorenko, and B. M. Chikhachev.
Kosmicheskie Issledovaniia, vol. 5, July-Aug. 1967, p. 608-616. 7 refs. In Russian.

Experimental investigation of the specific features of molecular-beam laser operation in a space environment. The stability of the laser frequency was measured by means of a two-way radio communications system with the satellite, in which the frequency shift due to the Doppler effect was automatically compensated. The frequency instability of the laser was found to be on the order of 10^{-11} during one prolonged period of continuous operation, and on the order of 10^{-10} for a prolonged period during which laser operation was repeatedly interrupted. V.P.

A67-38622
LASER WELDING - A STATUS REPORT.
Jon H. Myer (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.).
IN: ELECTRONIC PACKAGING CONFERENCE, NEW YORK, N.Y., FEBRUARY 14-16, 1967, PROCEEDINGS. [A67-38618 21-15]
Conference sponsored by the Society of Automotive Engineers.
New York, Society of Automotive Engineers, Inc., 1967, p. 22-24.

Discussion of current information on laser welding and laser-welding processes which appear promising. It is pointed out that the laser welder and particularly the pulsed ruby laser welder has evolved into a specialized tool for specialized applications in the

same class as the ultrasonic welder. Laser welders will not replace present welding equipment, but rather will supplement it and will not revolutionize the welding industry, but rather extend its potential. M.M.

A67-38640
PREAMPLIFIER OPERATING AT A WAVELENGTH OF 8 MM WITH A VERY LOW NOISE TEMPERATURE [UN PREAMPLIFICATEUR A 8 MM DE LONGUEUR D'ONDE A TRES FAIBLE TEMPERATURE DE BRUIT].
Y. de Coatpont and A. Robert (Compagnie Générale de Télégraphie sans Fil, Paris, France).
Société Française des Electroniciens et des Radioélectriciens, Colloque International sur l'Electronique et l'Espace, Paris, France, Apr. 10-15, 1967, Paper. 14 p. In French.

Discussion of the design, performance and applications of a very low noise preamplifier operating at a wavelength of 8 mm. The maser proved to be the most sensitive microwave receiver. The material used was the iron-doped rutile (TiO_2). The chosen maser is of the traveling-wave type. The specific electron gain measured on a short-length sample is 8 db for a concentration of 1250 ppm at an operating temperature of 4.2°K. The value of this specific gain decreases when it is necessary to use crystals only a few centimeters long. Rather than increasing the length of the crystals, it was deemed preferable to decrease the operating temperature. Thus, at 1.7°K, it is possible to obtain specific gains on the order of 6.5 db/cm. The utilization of the maser in space applications - in particular, satellite communications and radioastronomy - is discussed. M.F.

A67-38725 #
INVESTIGATION OF STRONG BLAST WAVES AND THE DYNAMICS OF LASER INDUCED PLASMAS IN HIGH PRESSURE GASES.
Otto M. Friedrich, Jr., Frederic Weigl, and Arwin A. Dougal (Texas, University, Dept. of Electrical Engineering, and Laboratories for Electronics and Related Science Research, Austin, Tex.).
American Institute of Aeronautics and Astronautics, Electric Propulsion and Plasmadynamics Conference, Colorado Springs, Colo., Sept. 11-13, 1967, Paper 67-696. 13 p. 57 refs.
Members, $0.75; nonmembers, $1.50.
Research supported by the Texas Atomic Energy Research Foundation; Grant No. AF AFOSR 766-67.

Strong shocks produced when 2 to 3 joules of energy are released in high pressure gases by focusing a giant pulse laser are investigated analytically and experimentally. Strong blast wave theory is employed to calculate the position, velocity, maximum pressure, and temperature as functions of time and energy absorbed by the gas in the shocks formed for several gases at pressure of 1 to 2000 atm. Experimentally, luminous fronts associated with strong blast waves produced in gases at pressures up to 2000 atm with a focused 30-mw, 40-nsec pulse ruby laser are observed with Kerr cell photography. Optical interferometry with a Mach-Zehnder interferometer, absorption of a helium-neon laser beam, and piezoelectric pressure sensitive probe measurements of strong shocks produced in air at STP with a 175 mw, 17-nsec giant pulse ruby laser show that during the rapid radial expansion of the shock, the measured position agrees to within 10% of that calculated. Relatively strong pressure fronts are observed at radii in excess of 50 cm and are spherical for radii larger than 2 cm. (Author)

A67-38734 #
DIAGNOSTICS OF MEDIUM AND DENSE PLASMAS USING SELF-FOCUSED LASER BEAMS.
A. R. M. Rashad.
American Institute of Aeronautics and Astronautics, Electric Propulsion and Plasmadynamics Conference, Colorado Springs, Colo., Sept. 11-13, 1967, Paper 67-707. 4 p. 7 refs.
Members, $0.75; nonmembers, $1.50.

The paper is concerned with the theory of a new technique for plasma diagnostics using self-focused laser beams. The density of electrons can be determined from the measurement of the laser's input power to the plasma and the self-focusing length. The temperature of electrons can be obtained also, if the interaction parameter γ describing the degree of interaction of the high frequency electromagnetic radiation from the laser beam with the plasma is calculated theoretically. (Author)

A67-38768
SERIES INTERFEROMETER FOR THE DIAGNOSIS OF A LARGE DIAMETER THETA-PINCH.
A. De Angelis and S. Martellucci (EURATOM and Comitato Nazionale per l'Energia Nucleare, Laboratorio Gas Ionizzati, Frascati, Italy).
Review of Scientific Instruments, vol. 38, Sept. 1967, p. 1255-1259. 13 refs.

An optical interferometer particularly suitable for the refractive diagnosis of large dimension plasmas is described. The theory of the instrument is revised in view of plasma applications. A detailed description of a 12-m long series interferometer working on a large-diameter theta-pinch is given. During the experiment, both a Q-switched ruby laser and a pulsed arc lamp were used. (Author)

A67-38772
ULTRASONIC INTERFEROMETER-LASER OPTICAL DIFFRACTION CELL FOR RAPID DETERMINATION OF THE VELOCITY OF SOUND IN LIQUIDS.
M. E. Pedinoff (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.) and H. Seguin (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.; Alberta, University, Dept. of Electrical Engineering, Edmonton, Alberta, Canada).
Review of Scientific Instruments, vol. 38, Sept. 1967, p. 1342-1344. 8 refs.

Description of a liquid ultrasonic resonator which has optical transmission windows attached to its side walls for generating laser-beam diffraction spectra. The device can be used to measure the velocity of sound to within 1% accuracy, provided that the radio frequency of the oscillator is known to better than 1%. The device is easily constructed, is simple to operate, and produces useful data rapidly. M.F.

A67-38813 #
NONLINEAR SIGNAL DISTORTIONS AND THE SATURATION OF SOLID-STATE MASERS.
N. V. Karlov and T. I. Kuznetsova (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Radiotekhnika i Elektronika, vol. 12, Feb. 1967, p. 284-293.)
Radio Engineering and Electronic Physics, vol. 12, Feb. 1967, p. 259-267. 8 refs. Translation.

Study of the propagation of a signal consisting of the sum of a weak field and a strong monochromatic field in a medium whose active properties can be described by a three-level scheme. The magnetic moment is determined with the aid of the density matrix. Formulas are obtained for the output fields of a three-level solid-state traveling-wave maser, when its input signal is a strong field at the resonant frequency and is accompanied by weak side bands. It is shown that the nonlinear interaction between weak fields leads to signal distortion. The cases of amplitude- and frequency-modulated input signals are considered. It is shown that maser saturation does not change the form of the modulation. A comparison between amplitude and frequency modulation leads to the conclusion that frequency modulation is more stable with respect to nonlinear distortions. M.F.

A67-38819
THE EFFECT OF GENERATION SELF-CUTOFF IN A RUBY LASER.
V. L. Broude, V. I. Kravchenko, P. P. Pogoretskii, E. N. Sal'kova, and M. S. Soskin (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki, Kiev, Ukrainian SSR).
(Akademiia Nauk SSSR, Doklady, vol. 173, Mar. 1, 1967, p. 64-66.)
Soviet Physics - Doklady, vol. 12, Sept. 1967, p. 214-216. 7 refs. Translation.
[For abstract see issue 12, page 1953, Accession no. A67-25445]

A67-38820
INVESTIGATION OF THE HYPERACOUSTIC PROPERTIES OF LIQUIDS BY MEANS OF A HELIUM-NEON LASER.
L. V. Lanshina, Iu. G. Shoroshev, and M. I. Shakhparonov (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR).
(Akademiia Nauk SSSR, Doklady, vol. 173, Mar. 1, 1967, p. 70-72.)
Soviet Physics - Doklady, vol. 12, Sept. 1967, p. 220-222. 8 refs. Translation.
[For abstract see issue 12, page 1953, Accession no. A67-25446]

A67-38823
NEGATIVE-ION GAS LASER.
B. M. Smirnov.
(Akademiia Nauk SSSR, Doklady, vol. 173, Mar. 11, 1967, p. 316-319.)
Soviet Physics - Doklady, vol. 12, Sept. 1967, p. 242-244. 6 refs. Translation.

Description of a laser scheme in which the atoms in the upper excited state are in thermodynamic equilibrium with the surrounding medium, thus making possible the use of a thermal method of excitation. In the proposed laser scheme the atoms in the upper excited state are formed as a result of a charge exchange between positive and negative ions which makes possible the maintenance of thermodynamic equilibrium between the atoms in the upper excited state and the surrounding gas, while the atomic density in the lower excited state is considerably less than its equilibrium value, owing to radiation. A. B. K.

A67-38824
FORMATION OF A LONG SPARK IN AIR BY WEAKLY FOCUSED LASER RADIATION.
N. G. Basov, V. A. Boiko, O. N. Krokhin, and G. V. Sklizkov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
(Akademiia Nauk SSSR, Doklady, vol. 173, Mar. 21, 1967, p. 538-541.)
Soviet Physics - Doklady, vol. 12, Sept. 1967, p. 248-251. 12 refs. Translation.
[For abstract see issue 13, page 2129, Accession no. A67-27628]

A67-38825
ONE POSSIBILITY OF INCREASING THE Q OF THE RESONATOR OF A NEODYMIUM LASER.
O. N. Voron'ko, N. A. Kozlov, A. A. Mak, B. G. Malinin, and A. I. Stepanov.
(Akademiia Nauk SSSR, Doklady, vol. 173, Mar. 21, 1967, p. 542, 543.)
Soviet Physics - Doklady, vol. 12, Sept. 1967, p. 252, 253. 6 refs. Translation.
[For abstract see issue 13, page 2130, Accession no. A67-27629]

A67-38851 #
LASER PLASMA PRODUCTION - A NEW AREA OF PLASMADYNAMICS RESEARCH.
Russell G. Meyerand, Jr. (United Aircraft Corp., United Aircraft Research Laboratories, East Hartford, Conn.).
(American Institute of Aeronautics and Astronautics, Plasmadynamics Conference, Monterey, Calif., Mar. 2-4, 1966, Paper 66-174.)
AIAA Journal, vol. 5, Oct. 1967, p. 1730-1737. 40 refs.

A67-38876 #
POINT MEASUREMENTS OF THE TIME-AVERAGED TURBULENT WAKE DENSITY BY RAYLEIGH SCATTERING.
E. Locke (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
AIAA Journal, vol. 5, Oct. 1967, p. 1888-1890. 7 refs.
Contracts No. AF 04(694)-983; No. DA-01-021-AMC-12005(Z).

Description of a technique that is well suited to make point measurements of the neutral gas density in turbulent high-pressure wakes behind a body traveling at hypersonic speeds. Laser light Rayleigh-scattered by the wake is used as a measure of the gas density. The experimental techniques and the limitations caused by the presence of very low levels of dust in the wake are explained. Some preliminary data on the time-averaged density for wakes of 0.22-in.-diam spheres at M = 2.5, 4, 6, and 9 are presented. F.R.L.

A67-38968
INFLUENCE OF BLOCK STRUCTURE AND SLIP PLANES ON THE DIVERGENCE OF THE LASER RADIATION OF RUBY CRYSTALS.
E. M. Akulenok, Kh. S. Bagdasarov, V. S. Papkov, and V. Ia. Khaimov-Mal'kov (Akademiia Nauk SSSR, Institut Kristallografii, Moscow, USSR).
(Kristallografiia, vol. 12, Mar.-Apr. 1967, p. 286-290.)
Soviet Physics - Crystallography, vol. 12, Sept.-Oct. 1967, p. 237-242. 5 refs. Translation.

It is shown that the presence of block structure and slip planes in crystals leads to an increase in the divergence of laser radiation and to a distortion of the front of this radiation. The divergence is specific for the radiation energy distribution in space and is mainly determined by diffraction at slip planes and block boundaries. The investigation of such passive divergence is qualitatively correlated with the active divergence. (Author)

A67-39011
SOME EFFECTS OF LASER RADIATION ON METALS.
A. N. Kokora and A. A. Zhukov (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Lekhkogo i Tekstill'nogo Mashinostroeniia, Moscow, USSR).
(Fiziko-Khimicheskaia Mekhanika Materialov, vol. 2, May-June 1966, p. 359, 360.)
Soviet Materials Science, vol. 2, May-June 1966, p. 257-259. 5 refs. Translation.

Discussion of evidence of various forms of mechanically produced damage during a recent investigation of the use of laser radiation pulses with energies ranging from 0.4 to 5 joules for drilling holes in steels 1Kh18N9T, E1629, and E1943 spinerettes. A photograph of a microsection in a plane of the axis of a blind hole made with a laser in a 0.3-mm thick steel E1943 plate is shown. The photomicrograph also shows an annular crack which extends over the entire unpierced portion of the plate and appears to be a continuation of the hole walls. It is pointed out that, although the nature of the side effects of laser radiation is still somewhat obscure, it can be concluded that the purely thermal effects of laser radiation are accompanied by mechanical effects, which are sometimes explosive, and which need to be thoroughly investigated. M.M.

A67-39066
OPTICAL INTERFEROMETRY.
M. Françon (Paris, Université, Institut d'Optique, Paris, France). New York and London, Academic Press, 1966. 316 p. Translation. $13.50.

The book treats interference phenomena from the point of view of the coherence theory. Types of interference considered include interferences of two waves by wave-front division, interference of two waves by amplitude division, multiple-beam interference, and laser interference. Among the topics discussed are intensity interferometry, interference spectroscopy, polarization interferometers and their applications, and interferometric measurements of the optical transfer functions. Examples of two-beam interferometers covered are the Michelson, Mach-Zehnder, and Jamin interferometer. The Fabry-Pérot interferometer is investigated as an example of the multiple-beam type of interferometer, with emphasis on the limit of resolution of this type. The principle of the polarization interferometer is studied, and several birefringent systems with linear and angular shearing are analyzed. Following a section on interference and partial coherence, the Hanbury-Brown and Twiss interferometers are investigated, with attention drawn to the relation between the intensity fluctuations and the degree of partial coherence. In the field of noncoherent illumination, the interferometric measurement of the transfer function of an optical instrument is described. Diverse applications of interference are presented, including the use of interferences for the measurement of length. Other examples of interferometers treated are the Twyman-Green, Martin-Watt-Weinstein, Bates, and Burch interferometers. R.B.S.

A67-39117
PHOTOSTATISTICS OF AN N-MODE LASER FIELD.
M. Bertolotti, B. Crosignani, P. Di Porto, and D. Sette (Istituto Superiore delle Poste e delle Telecomunicazioni; Roma, Università, Istituto di Fisica, Rome, Italy).
Zeitschrift für Physik, vol. 205, no. 2, 1967, p. 129-136. 9 refs.
Research supported by the Consiglio Nazionale delle Ricerche.

The statistical properties of an electromagnetic field obtained by the superposition of N ideal modes are theoretically investigated. The second-order moment of the photostatistics contains N(N-1)/2 non-Poissonian terms, each one oscillating with the frequency difference between the frequencies of two modes. A simple formalism makes it possible to establish the conditions under which the photostatistics tend to a Bose-Einstein form when $N \to \infty$. The main

differences between this field and a Gaussian one are also investigated. (Author)

A67-39199 #

THE OPTICS OF LASER STREAK INTERFEROMETRY.

L. H. Tanner (Belfast, Queen's University, Aeronautical Engineering Dept., Belfast, Northern Ireland).

Journal of Scientific Instruments, vol. 44, Sept. 1967, p. 725-730.

Analysis of the effects of displacements of one beam of a laser-streak interferometer relative to another on the image-intensity distribution, and hence on the visibility of the streak fringes. Beam displacements likely to be produced by optical-path variations within a two-dimensional phase object are considered, and the results are compared with previous work. Conclusions are made concerning the beam sizes and convergence angles which should be used to obtain the best resolution. B.B.

A67-39244

EVIDENCE FOR A THERMONUCLEAR REACTION IN A ϑ-PINCH PLASMA FROM THE SCATTERING OF A RUBY LASER BEAM.

S. A. Ramsden, P. K. John, B. Kronast, and R. Benesch (National Research Council, Div. of Pure Physics, Ottawa, Canada).

Physical Review Letters, vol. 19, Sept. 18, 1967, p. 688, 689. 6 refs.

Verification of preliminary results of a comparison of the neutron yield in a ϑ-pinch plasma with the ion temperature determined from the scattering of a ruby laser beam. It is confirmed that within the limits of error, the neutron yield from the plasma is well accounted for in terms of the measured values of the ion temperature, density, and total number of reacting particles and that the neutron emission observed appears to be of truly thermonuclear origin. M.F.

A67-39253 *

HIGH-POWER PULSED GaAs LASER DIODES OPERATING AT ROOM TEMPERATURE.

Herbert Nelson (Radio Corporation of America, RCA Laboratories, Princeton, N.J.).

IEEE, Proceedings, vol. 55, Aug. 1967, p. 1415-1419. 11 refs.
Contracts No. DA-28-043-AMC-02471(E); No. NAS 9-6195.

The fabrication and characteristics of a high-power GaAs injection laser for room-temperature operation are described. A single laser emits 70 watts peak power from one facet at four times the threshold current. The diodes are fabricated from epitaxial wafers prepared by the solution-growth process. Scalling from work on low-power (7-watt) units to this high power has been accomplished by increasing the junction width, which requires general improvement in the crystalline quality and in the control of the doping. Data are given on the effect of doping density, crystal quality, and imperfections near the junction, as well as junction width. The reduced yield in high-power diodes, of which only one-third from a single batch give the desired output, is associated with filamentary lasing and with superradiant walk-off modes, neither of which is under full control. Preliminary data on life tests show that long-lived units can be made, but that apparently identical units from the same batch show wide variations in the rate of degradation. (Author)

A67-39258

A LASER-TRIGGERED 50 PPS HIGH-VOLTAGE SWITCH WITH NANOSECOND JITTER.

Arthur H. Guenther and Ronald H. McKnight (USAF, Systems Command, Research and Technology Div., Weapons Laboratory, Kirtland AFB, N. Mex.).

IEEE, Proceedings, vol. 55, Aug. 1967, p. 1504. 6 refs.

Description of the application of recently developed Nd(3+) doped YAG laser systems to switch a high-voltage spark gap at rates up to 50 pps with a jitter of approximately 1 nsec. Using a Pockels cell for Q-spoiling, the 5 by 50-mm YAG crystal produced approximately 25 mjoule per pulse at 1.06 μ with a pulse width of 7 nsec. The demonstrated ability to switch a spark gap at high repetition rates with low jitter is of importance in many pulsed power systems such as high-power, low-jitter modulators, cineradiography, and other stroboscopic applications. M.F.

A67-39333

THE PULSED GAS LASER AND ITS APPLICATION TO MICRO CIRCUIT FABRICATION.

A. D. Brisbane and T. M. Jackson (International Telephone and Telegraph Corp., Standard Telecommunication Laboratories, Ltd., Materials and Components Div., Harlow, Essex, England).

IN: NEW DEVELOPMENTS IN OPTICS AND THEIR APPLICATIONS IN INDUSTRY; BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION, CONFERENCE, EASTBOURNE, SUSSEX, ENGLAND, APRIL 10-12, 1967, PAPERS.. [A67-39328 22-23]
Chislehurst, Kent, England, British Scientific Instrument Research Association, 1967, p. 12-1 to 12-15.

Description of a helium-neon high-power pulsed gas laser, with its operating and performance characteristics. Curves are shown which illustrate the noncritical relationship between output power and gas filling. The laser operates in the IR using the $2S_2 \rightarrow 2P_4$ neon transition at $\lambda = 1.15\ \mu$. The peak power is approximately 200 watts with a pulse duration of 500 nsec at a recurrence frequency up to 2 kHz. Several tests to determine the conditions of laser power and beam area which seve to control the width of line cut in various metallic films are described. The capabilities of a complete system incorporating a gas laser and an automatic tape-controlled coordinate machining table are discussed. A specific application of laser beam in the large-scale integration of semiconductor circuits is described. The technique is shown to introduce a high degree of flexibility into the fabrication of integrated circuits. M.M.

A67-39349

GAIN SATURATION IN NEODYMIUM - GLASS LASER AMPLIFIERS.

A. Y. Cabezas, G. L. McAllister, and W. K. Ng (Hughes Aircraft Co., Aerospace Group, Culver City, Calif.).

Journal of Applied Physics, vol. 38, Aug. 1967, p. 3487-3491. 15 refs.
Contract No. AF 33(615)-3918.

Gain saturation in an Nd^{3+}:glass (Corning 0580) laser amplifier has been investigated using a normal laser driving signal. The study shows that only the average power of the driving signal need be specified. The experimental results obtained agree with the steady-state theory of Schulz-DuBois on the gain saturation of an amplifier with loss. This leads to a value of $3.5 \pm 1.0 \times 10^{-20}$ cm^2 for the amplifier stimulated-emission cross section σ_a. From this and the measured value of 3.3×10^3 sec^{-1} for the spontaneous emission rate A, the critical saturable power P_c is calculated to be about 20 kw/cm^2. P_c is defined as the level that reduces the unsaturated steady-state inversion density by 3 db; it is given approximately by $Ah\nu_L/\sigma_a$. When unsaturated, the steady-state gain of the amplifier studied was 29.3 ± 3.8 db; correspondingly, the gain coefficient β was 0.34 ± 0.04 cm^{-1} and the inversion excitation rate W was about 30 sec^{-1}. When driven to saturation by 82.5 kw/cm^2 (the maximum normal laser driving power used in the experiment), 3.0 ± 0.2 db of steady-state gain was measured. The loss coefficient α of the amplifier was found to be 0.011 ± 0.002 cm^{-1} at 1.06 μ. (Author)

A67-39354

EFFECTS OF CO_2, He, AND N_2 ON THE LIFETIMES OF THE 00^01 AND 10^00 CO_2 LASER LEVELS AND ON PULSED GAIN AT 10.6 μ.

P. K. Cheo (Bell Telephone Laboratories, Inc., Whippany, N.J.).

(American Physical Society, Meeting, Austin, Tex., Feb. 23-25, 1967, Paper.)
Journal of Applied Physics, vol. 38, Aug. 1967, p. 3563-3568. 10 refs.

Study of the relaxation times of the 00^01 and 10^00 CO_2 vibrational levels and the afterglow gain at 10.6 μ, for 22- and 34-mm-bore nonflowing laser amplifiers. The gas mixtures under consideration were pure CO_2, CO_2:He, and CO_2:N_2. Measurements of the exponential rise τ_r, and decay γ_d times of the afterglow gain pulse were made using a CW 10.6-μ CO_2 laser as the amplifier input radiation source. Evidence is presented to support the interpretation of τ_r, and τ_d as measures of the effective lifetimes of the 10^00 and 00^01 CO_2 laser levels, respectively. The relative values of optimum amplifier gain in the afterglow for all gas mixtures studied are consistent with those obtained from CW gain measurements. R.B.S.

A67-39428

RELATIONSHIP BETWEEN ELECTRON DENSITY AND OUTPUT POWER IN A He-Ne LASER.

A. E. Fotiadi and S. A. Fridrikhov (Leningradskii Politekhnicheskii Institut, Leningrad, USSR).

(Zhurnal Tekhnicheskoi Fiziki, vol. 37, Mar. 1967, p. 566-571.)
Soviet Physics - Technical Physics, vol. 12, Sept. 1967, p. 406-410. 7 refs. Translation.

The results are given of an experimental study, employing a microwave resonator technique, of the relationship between the electron density and the output power of a helium-neon laser ($\lambda = 0.63\ \mu$) for various pressures of the gas mixture and various ratios between the components of the mixture. For $p = 0.6$ mm Hg, $p_{Ne}/p_{He} = 1/8$, and a tube diameter of $d = 6$ mm, the laser begins to oscillate at an electron density $N_{e\ th} \simeq 1.5 \times 10^{10}$ cm^{-3}. The optimum electron density, corresponding to maximum output power, is $N_{e\ opt} \simeq 4.5 \times 10^{10}$ cm^{-3}. The laser ceases to oscillate at $N_{e\ stop} \simeq 10^{11}$ cm^{-3}. The effect on the electron density and output power of an axial magnetic field is investigated. (Author)

A67-39436

QUANTUM THEORY OF A SIMPLE MASER OSCILLATOR.

J. P. Gordon (Bell Telephone Laboratories, Inc., Murray Hill, N. J.).

Physical Review, 2nd Series, vol. 161, Sept. 10, 1967, p. 367-386. 14 refs.

We discuss the quantum theory of a simple model of a maser oscillator, consisting of one radiation-field mode interacting with a large number of stationary three-level atoms. The field and the atoms also interact with separate heat reservoirs which represent dissipation mechanisms and an incoherent pumping mechanism. The model is sufficiently simple that some analytical progress can be made with the nonlinear quantal equations before further approximation is necessary. We start from the quantal equation of motion of the field-atom density operator. We make immediate use of a diagonal coherent-state expansion for the field part of the density operator and a somewhat similar expansion for the atom part. This yields an exact equation of the Fokker-Planck form for a c-number weight distribution, which retains all the significance of the original operator equation, and which has the semiclassical equation for the same model as a first, fluctuation-free approximation. We make use of our basic Fokker-Planck equation in a variety of ways. We discuss the reduction of the equation under conditions that the atomic decay constants are large (large atomic line width), arriving finally at an equation of motion for a field-only weight function which serves to demonstrate the basic coherence properties of a maser. We derive and discuss the equation of motion of the generalized Wigner density for the maser model. The generalized Wigner density is a smoothed version (a convolution) of our basic weight distribution, and from it we derive an equivalent classical model including noise sources. Finally, we discuss other useful weight distributions and the number representation for the field. The equations we derive in these discussions make contact with the rate equations of Shimoda, Takahasi, and Townes, as well as with the more recent work of Lax and Louisell, Lax, and of Scully and Lamb. (Author)

A67-39445

LASER SYSTEMS AND APPLICATIONS.

H. A. Elion (Geophysics Corporation of America, GCA Technology Div., Modern Optics Laboratory, Bedford, Mass.).

Oxford and New York, Pergamon Press, 1967. 642 p. $22.50.

This book is devoted to the fundamental principles of laser operation and describes various types of lasers currently in use, their operating characteristics, and applications. Light amplification by stimulated emission of radiation is examined with a brief review of quantum electronics and the characteristics of coherent radiation. Types of lasers studied include solid-state lasers, semiconductor lasers, gas lasers, liquid lasers, and chemical lasers. Laser modulation, demodulation, and detection are investigated in relation to steady-state and transient behavior, waveguides, Q-switching, amplitude, and frequency. Energy-intensity and measurement applications are considered, including uses in metallurgy, weapons, biology, chemistry, and photochemistry. Spectral applications are discussed in photography, micrography, spectrography, and plasma research. Ranging, surveying, metrology, and navigation provide further laser applications. Also considered are laser techniques in communications, optical data processing and display, and certain future prospects. A subject and author index from the NASA SP-7009 document (a continuing bibliography) is given in the appendix for the period from January 1962 to July 1966. This continuing bibliography contains material compiled from documents announced in Scientific and Technical Aerospace Reports (STAR) and International Aerospace Abstracts (IAA). Complete bibliographic information is not included, and reference must be made to the NASA SP or the individual announcements in STAR or IAA. T.M.

A67-39458

SOLID STATE LASER WITH MODE SELECTION WITHIN AN ACTIVE ELEMENT.

N. G. Bondarenko, I. V. Eremina, and B. I. Talanov (Gor'kovskii Gosudarstvennyi Universitet, Nauchno-Issledovatel'skii Radiofizicheskii Institut, Gorki, USSR).

(ZHETF Pis'ma v Redaktsiiu, vol. 6, July 1, 1967, p. 459-461.)
JETP Letters, vol. 6, July 1, 1967, p. 1-3. Translation.

Description of a solid-state pulsed laser free to a considerable degree of the shortcomings (losses, increased threshold pump power, lowered useful generator power) induced by use of selecting elements such as diaphragms, Fabry-Pérot interferometers, and total internal reflection prisms placed inside the laser cavity. In the laser described, the selective element is the active medium itself. The active rod is in the form of a prism of rectangular cross section with two plane-parallel polished surfaces. The laser ensures collimation of the beam in one plane. It may be useful in second-harmonic generation and parametric frequency conversion systems, in which small beam divergence is required in the synchronism plane only. F. R. L.

A67-39461

COHERENT EMISSION OF InP OPTICALLY EXCITED BY AN INJECTION LASER.

P. G. Eliseev, I. Ismailov, and L. I. Mikhailina (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).

(ZHETF Pis'ma v Redaktsiiu, vol. 6, July 1, 1967, p. 479-481.)
JETP Letters, vol. 6, July 1, 1967, p. 15, 16. 8 refs. Translation.

Observation, for the first time, of coherent emission in optically excited indium phosphide. The exciting radiation source was a GaAs injection laser of diffusion type. The experiments were carried out at 77°K. The possibility of attaining generation depends in a critical fashion on accurately setting the sample in such a way that the laser-illuminated strip is strictly perpendicular to the mirrors. F. R. L.

A67-39492 * #

FLUORESCENT PHOTOGRAPHY OF DROPLETS IN A SPRAY USING A Q-SWITCHED LASER AS A LIGHT SOURCE.

J. Groeneweg (Wisconsin, University, Madison, Wis.; NASA, Lewis Research Center, Cleveland, Ohio), H. Hiroyasu, and R. Sowls (Wisconsin, University, Madison, Wis.).

British Journal of Applied Physics, vol. 18, Sept. 1967, p. 1317-1320. NSF-sponsored research.

A method of using a Q-switched laser as a light source for photographing droplets in a spray is described. A fluorescent dye in the liquid being sprayed was excited by the second harmonic of ruby light at 3471 Å. Droplets as small as 10 μ, traveling with velocities as high as 50 m/sec, were successfully photographed. A dynamic size calibration showed that reliable drop size information could be obtained from the spray photographs. (Author)

A67-39511 #

PHOTOCONDUCTIVITY OF CdS INDUCED BY LIGHT FROM A RUBY LASER [FOTOPROVIDNIST' CdS, ZBUDZHUVANA SVITLOM RUBINOVOGO LAZERA].

A. O. Borshch, M. S. Brodin, and M. V. Kurik (Akademiia Nauk Ukrains'koi RSR, Institut Fiziki, Kiev, Ukrainian SSR).

Ukrains'kii Fizichnii Zhurnal, vol. 12, Aug. 1967, p. 1382, 1383. In Ukrainian.

Brief note on the photoconductivity induced in CdS crystals by ~ 5-Mw single pulses of light from a ruby laser with a modulated

Q-factor. The dependence of the photocurrent on laser power is shown in diagram form, and an oscillogram of the photocurrent is given. V. Z.

A67-39522 #
MEASUREMENTS ON THE ANOMALOUS NON-LINEAR PREFERENCE FOR CIRCULAR MODE POLARIZATION IN A 1.523 μ He-Ne LASER.
H. De Lang and G. Bouwhuis (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands).
Physics Letters, vol. 25A, Sept. 11, 1967, p. 406, 407.

Description of measurements of the anomalous nonlinear preference for circular polarization ("polarophily") of a 1.523-μ He-Ne laser, in particular, as a function of gas pressure. In the pressure range investigated the anomalous polarophily of the 1.523-μ He-Ne laser shows a marked tendency to increase with decreasing total gas pressure. M.F.

A67-39614
ELECTRON AFFINITY OF HELIUM VIA LASER PHOTODETACHMENT OF ITS NEGATIVE ION.
B. Brehm, M. A. Gusinow, and J. L. Hall (National Bureau of Standards and Colorado, University, Joint Institute for Laboratory Astrophysics, Boulder, Colo.).
Physical Review Letters, vol. 19, Sept. 25, 1967, p. 737-741. 10 refs.
Contract No. DA-31-124-ARO(D)-139.

Discussion of the first direct measurement of the electron affinity of helium (2^3S), by the technique of energy analysis of electrons photodetached from a beam of negative helium ions by monochromatic (laser) light. In the experiment described an analysis was made of the energy of the electrons photodetached from a beam of negative helium ions passing through the high-power intracavity electromagnetic field of a continuous-duty argon-ion laser. The experimental results are summarized in tabular form. M.F.

A67-39633
THEORY AND APPLICATIONS OF HOLOGRAPHY.
J. B. DeVelis (Merrimack College, Dept. of Physics, North Andover, Mass.) and G. O. Reynolds (Technical Operations, Inc., Burlington, Mass.).
Reading, Mass., Addison-Wesley Publishing Co., 1967. 206 p. 279 refs.
$12.95.

This text analyzes various hologram systems which have been introduced to date and describes some of the more highly developed applications. The historical development of hologram techniques is outlined, and a rigorous mathematical analysis is included, to emphasize the nature of the general hologram process as a problem in the classical theory of practical coherence. The coherent and incoherent limits are introduced and treated as special cases of the more general partially coherent case. Such properties of each system as magnification, film effects, resolution, and temporal and spatial coherence effects are discussed in detail. A review is given of the various applications of holography that existed at the time of writing, and an extensive list of the publications which supplement those used in the text is given. B.B.

A67-39651
MEASUREMENT OF LANDE FACTORS OF NEON BY STUDYING THE SATURATIONS CAUSED BY A MULTIMODE LASER BEAM [MESURE DE FACTEURS DE LANDE DU NEON PAR L'ETUDE DES SATURATIONS PROVOQUEES PAR UN FAISCEAU LASER MULTIMODE].
Bernard Decomps and Michel Dumont (Paris, Université, Ecole Normale Supérieure, Laboratoire de Spectroscopie Hertzienne, Paris, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 265, no. 4, July 24, 1967, p. 249-252. 9 refs. In French.

Measurement of the Landé factor of $2\,s_2$, $2\,p_4$, and $3\,p_4$ levels. The resonant saturations observed in the fluorescent light emitted by neon atoms subjected to a magnetic field and to irradiation of a multimode laser were used in these measurements. F.R.L.

A67-39738 #
FLUCTUATIONS IN THE RADIATION INTENSITY AND FREQUENCY OF A LASER [FLUKTUATSII INTENSIVNOSTI I CHASTOTY IZLUCHENIIA OPTICHESKOGO GENERATORA].
I. L. Bershtein, I. A. Andronova, and Iu. I. Zaitsev (Gor'kovskii Gosudarstvennyi Universitet, Nauchno-Issledovatel'skii Radiofizicheskii Institut, Gorki, USSR).
Radiofizika, vol. 10, no. 1, 1967, p. 59-67. 10 refs. In Russian.

Investigation of the fluctuations in the radiation of a single-mode, continuously operating laser. The analysis is based on a phenomenological description of the properties of an active medium characterized by electrical polarization. Formulas are derived for the spectral densities of the fluctuations and for the intrinsic width of the emission line. Numerical values for the parameters included in these formulas may be determined on the basis of any realistic model or by experiment. Some results are compared with experimental data, and qualitative consideration is given to the case of a multimode regime. T.M.

A67-39739 #
THE EXPANSION OF A LASER BEAM IN A TURBULENT MEDIUM [K VOPROSU O RASSHIRENII LAZERNOGO PUCHKA V TURBULENTNOI SREDE].
Z. I. Feizulin and Iu. A. Kravtsov (Akademiia Nauk SSSR, Radiotekhnicheskii Institut, Moscow, USSR).
Radiofizika, vol. 10, no. 1, 1967, p. 68-73. In Russian.

Analysis of the expansion of a spatially limited laser beam propagating through a turbulent medium. The expansion of a plane wave of laser radiation at the limit of the turbulent medium is examined on the basis of the Huygens-Kirchhoff principle and an approximation of Fresnel diffraction. The spreading of the beam caused by scattering at inhomogeneities in the medium is considered, as well as the diffraction divergence of the beam and its fluctuation as a single entity near the unperturbed position. T.M.

A67-39759 #
CONTRIBUTION TO THE THEORY OF STEADY LASER OSCILLATIONS WITH ALLOWANCE FOR DIFFUSION EFFECTS [K TEORII STATSIONARNYKH KOLEBANII V LAZERE S UCHETOM EFFEKTOV DIFFUZII].
E. S. Kovalenko (Tomskii Institut Radioelektroniki i Elektronnoi Tekhniki, Tomsk, USSR).
Radiofizika, vol. 10, no. 2, 1967, p. 197-202. 5 refs. In Russian.

Discussion of the system of Maxwell equations for the density matrix, taking the effects of diffusion into account. A solution is obtained showing that diffusion cannot lead to any qualitative changes in the field-distribution pattern. Estimates are obtained on the spatial spectrum of the nonlinear modes, with allowance for diffusion. It is shown that the known equations of the one-dimensional laser model can be obtained as special cases of very large or very small diffusion. V.P.

A67-39760 #
POSSIBILITY OF INCREASING THE FREQUENCY OF LASER EMISSION WITH THE AID OF A THREE-PHOTON COMBINATION PROCESS [O VOZMOZHNOSTI POVYSHENIIA CHASTOTY IZLUCHENIIA OKG S POMOSHCH'IU TREKHFOTONNOGO KOMBINATSIONNOGO PROTSESSA].
V. S. Butylkin and Iu. G. Khronopulo (Akademiia Nauk SSSR, Institut Radiotekhniki i Elektroniki, Moscow, USSR).
Radiofizika, vol. 10, no. 2, 1967, p. 203-208. 7 refs. In Russian.

Discussion of forced three- and two-photon combination processes occurring simultaneously in a substance within a laser resonant cavity. It is shown that, no preventive measures being taken, the three-photon process will be suppressed by the two-photon (Stokes) process and that the latter process can be removed by introducing a substance into the cavity capable of absorbing radiation at the Stokes frequency. The limits within which the ratio of the working substance to the absorbing substance may be varied are determined, together with the laser-field strength which gives rise to an induced three-photon process. V.P.

A67-39765 #
MIXING OF THE EMISSIONS FROM RUBY AND NEODYMIUM LASERS [SMESHENIE IZLUCHENII RUBINOVOGO I NEODIMOVOGO LAZEROV].
N. N. Beliaeva, V. A. Demidov, and M. A. Novikov (Gor'kovskii Gosudarstvennyi Universitet, Nauchno-Issledovatel'skii Radiofizicheskii Institut, Gorki, USSR).
Radiofizika, vol. 10, no. 2, 1967, p. 294-296. In Russian.

Experimental investigation of the creation of a wave from the light waves of a ruby laser and a neodymium-glass laser. It is found that the frequency of the created wave is equal to the sum of the frequencies of the two initial waves, and that the power emitted at the combined frequency is equal to 40 kw. V.P.

A67-39780
INFRARED-LASER RANGEFINDER.
T. Bakker (National Defence Research Organization T.N.O., Physics Laboratory, Hague, Netherlands).
Applied Scientific Research, vol. 17, no. 6, 1967, p. 397-406. 10 refs.

A rangemeter, working at 1.06 μ, using neodymium-doped glass rods, is described. By applying a rotating prism (15,000 rpm) as a Q-switch, a single pulse is emitted. At a pump energy of 55 joules the peak power is 1 Mw and the rise time is 20 nsec. It is shown that the peak value of the noise is most important. The different noise characteristics of photomultipliers and high-frequency photodiodes are discussed, and a figure of merit relating their performances is defined. It turns out that at a wavelength of 1.06 μ the photodiode is superior. The performance of the rangefinder is given. The maximum distance which can reliably be measured is plotted against the visual range. The dependence of this curve on different atmospheric conditions (fog, rain, snow) is considered. The device is comparable in performance to those using ruby, with the following advantages: (1) the pump energy is reduced by a factor of 5, leading to a reduction in size and weight; (2) the homogeneity and low losses of the material facilitate the construction of the Q-switch; and (3) the attenuation, due to scattering in the atmosphere, is much smaller at the longer wavelength of the neodymium laser. (Author)

A67-39784 #
QUANTUM-MECHANICAL CALCULATION OF THE PHOTON NUMBER AND THE AMPLITUDE FLUCTUATIONS OF A LASER RADIATION [QUANTENMECHANISCHE BERECHNUNG DER PHOTONENZAHL UND AMPLITUDENFLUKTUATION EINER LASERSTRAHLUNG].
W. Brunner (Deutsche Akademie der Wissenschaften, Institut für spezielle Probleme der theoretischen Physik, Berlin, East Germany).
Annalen der Physik, vol. 20, no. 1-2, 1967, p. 53-67. 10 refs. In German.

Derivation of a system of two coupled equations which contain only b+b, b+bb+b, and the fluctuation operators from the quantum-mechanical equations describing a laser. It is found that far above the laser threshold the relative amplitude fluctuation decreases with increasing pumping intensity and therefore increasing photon number. However, the relative amplitude fluctuation also remains approximately constant in the case of increasing photon number, if the latter is achieved by varying those experimental parameters which also increase the number of spontaneous quanta. P. v. T.

A67-39921 #
LASER EMISSION ATTENUATION IN ARTIFICIAL WATER FOGS [OSLABLENIE IZLUCHENIIA OPTICHESKIKH KVANTOVYKH GENERATOROV V ISKUSSTVENNYKH VODNYKH TUMANAKH].
V. I. Bukatyi, M. V. Kabanov, B. P. Koshelev, B. A. Smirnov, B. A. Savel'ev, and S. S. Khmelevtsov (Tomskii Gosudarstvennyi Universitet, Sibirskii Fiziko-Tekhnicheskii Institut, Tomsk, USSR).
Fizika, vol. 10, no. 8, 1967, p. 142-144. In Russian.

Experimental study of the attenuation of continuous and pulsed emission from He-Ne, Nd-glass, and ruby lasers in artificial water fogs of various optical thicknesses, at 0.63, 0.69, 1.06, 1.15, and 3.39 μ. Diagrams are given for the attenuation factor of the laser emission and for the attenuation factor of the radiation from an incandescent heat source. Both attenuation factors are found to be equal for the optical thicknesses studied. V.Z.

A67-39923 #
GAS-LASER DEMONSTRATION [DEMONSTRATSII S GAZOVYM OPTICHESKIM KVANTOVYM GENERATOROM].
V. S. Mikhalevskii, V. F. Papakin, and M. F. Sem (Rostovskii-na-Donu Gosudarstvennyi Universitet, Rostov, USSR).
Fizika, vol. 10, no. 8, 1967, p. 156-158. In Russian.

Brief note on a technique for simulating in a simple but instructive way the operation of a gas laser to facilitate the teaching of laser physics. An assembly is described to demonstrate the transmission of information by modulation at 6328 Å of the coherent radiation of an He-Ne laser. V.Z.

A67-39960
INFLUENCE OF IR FREQUENCIES ON TRACKING FOR OPTICAL COMMUNICATION.
E. B. Moss (McDonnell Douglas Corp., Douglas Aircraft Co., Missile and Space Systems Div., Advance Electronics Dept., Electro-Optics Branch, Santa Monica, Calif.).
IN: AMERICAN ASTRONAUTICAL SOCIETY, SOUTHEASTERN SYMPOSIUM ON MISSILES AND AEROSPACE VEHICLES SCIENCES, HUNTSVILLE, ALA., DECEMBER 5-7, 1966, PROCEEDINGS. VOLUME 1. [A67-39926 22-31]
Symposium sponsored by the American Astronautical Society, the University of Alabama, NASA Marshall Space Flight Center, and the Missile Command of the U.S. Army.
Huntsville, Ala., American Astronautical Society, Southeast Section, 1966, p. 38-1 to 38-12. 10 refs.

Discussion of beam formation for optical communication between earth and interplanetary spacecraft and examination of the tracking problem, detectors, and their characteristics. It is pointed out that the microscopic dimensions of semiconductor wideband detectors, rather than beamwidth, will determine tracking requirements for cooperative optical communication at the present state of detector technology. It is noted that means of increasing the effective area of detection without prejudice to performance need investigation. This investigation should explore optical and electronic approaches, as well as fundamental research in solid-state detector technology. M.M.

A67-39981 #
LASERS AND THE PROSPECTS OF THEIR APPLICATION IN OPTICAL RANGE FINDERS [OPTICHESKIE KVANTOVYE GENERATORY I PERSPEKTIVY PRIMENENIIA IKH V SVETODAL'NOMERAKH].
V. M. Nazarov.
Geodeziia i Kartografiia, Aug. 1967, p. 10-21. 10 refs. In Russian.

Review of the principles of laser operation and evaluation of the applicability of lasers as the light source in optical telemetry. Laser radiation is described in terms of the atomic energy levels and electron transitions causing photon emission. Various solid-state and gas lasers are examined, and critical parameters influencing operation are studied. Requirements posed by optical telemetry are surveyed and compared with laser advantages and limitations. The use of a He-Ne laser for measuring distance is described, together with the use of solid-state lasers in topography. Several conclusions reached on the basis of laser applications within these fields in the Soviet Union are discussed. T.M.

A67-40126 #
LINEAR THEORY OF A CYCLOTRON MASER [LINEINAIA TEORIIA TSIKLOTRONNOGO MAZERA].
A. F. Kurin (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR).
Radiofizika, vol. 10, no. 8, 1967, p. 1160-1164. 7 refs. In Russian.

Discussion of the effect of a perturbing linearly polarized electric field of a resonant cavity situated in a constant uniform magnetic field (oriented along the resonator axis) on a monochromatic (with respect to pulses) electron flux passing through the resonant cavity. An expression for the excitation current is derived under the assumption of a slow relativistic motion of the electrons. The dependence of the maser frequency on the resonator tuning is examined. V.P.

A67-40128 #
ACTIVE-MEDIUM GAIN OF GAS LASERS [O KOEFFITSIENTE USILENIIA AKTIVNOI SREDY GAZOVYKH OKG].
V. I. Matveev (Moskovskoe Vysshee Tekhnicheskoe Uchilishche, Moscow, USSR).
Radiofizika, vol. 10, no. 8, 1967, p. 1188, 1189. 6 refs. In Russian.

Derivation of an analytical expression for the active-medium gain required in the calculation of gas-laser output power. Contrary to the conventional approach, in which expressions of this type are calculated either for a purely homogeneous or purely inhomogeneous spectral line broadening, the expression proposed is obtained for the intermediate case, which is better suited to gas-laser operation. V.P.

A67-40139
A PLANETARY GEODETIC LASER SURVEY SYSTEM.
R. A. Fowler (North American Aviation, Inc., Space and Information Systems Div., Space Sciences Dept., Geophysics Group, Downey, Calif.), V. Castellano (North American Aviation, Inc., Space and Information Systems Div., Downey, Calif.), and E. L. Cohn (North American Aviation, Inc., Space and Information Systems Div., Downey, Calif.).
IN: AMERICAN ASTRONAUTICAL SOCIETY, SOUTHEASTERN SYMPOSIUM ON MISSILES AND AEROSPACE VEHICLES SCIENCES, HUNTSVILLE, ALA., DECEMBER 5-7, 1966, PROCEEDINGS. VOLUME 2. [A67-40134 22-31]
Symposium sponsored by the American Astronautical Society, the University of Alabama, NASA Marshall Space Flight Center, and the Missile Command of the U.S. Army.
Huntsville, Ala., American Astronautical Society, Southeast Section, 1966, p. 57-1 to 57-10.

Description of an optical technique, using a laser source, to provide highly accurate range measurements over distances of up to 20 km. The theory of this technique, based on the dispersion between two different wavelengths of light, is developed from fundamental optical principles, and the system is described. It is shown that this technique necessarily requires a knowledge of the index of refraction under standard conditions (STP), but requires no additional information concerning the temperature or pressure variations over the propagation path. Preliminary results of system tests are presented and compared with theory. Since the system is capable of continuously monitoring the distance between two points, it also allows long-term measurements of tectonic activity in new areas without the necessity of a controlled optical environment. This and other potential applications are discussed in terms of planetary exploration. P.v.T.

A67-40237
ATMOSPHERIC ABSORPTION OF CO_2 LASER RADIATION.
John C. Stephenson, William A. Haseltine, and C. Bradley Moore (California, University, Dept. of Chemistry, Berkeley, Calif.).
Applied Physics Letters, vol. 11, Sept. 1, 1967, p. 164-166.
10 refs.
NSF-ARPA-supported research.

Calculation of the absorption of CO_2 laser radiation by the atmosphere from laboratory absorption-coefficient measurements. The atmospheric absorption of the CO_2-laser P_{20} line is tabulated. It is pointed out that molecular absorption lines, particularly those of CO_2, can cause attenuation in communications or power transmission applications involving distances of tens of kilometers. M.F.

A67-40241
ISOTOPIC ANALYSIS OF RARE GASES WITH A LASER MICROPROBE.
G. H. Megrue (Smithsonian Institution, Smithsonian Astrophysical Observatory and Harvard University, Dept. of Astronomy, Harvard College Observatory, Cambridge, Mass.).
Science, vol. 157, Sept. 29, 1967, p. 1555, 1556. 9 refs.

A ruby-pulsed laser and high-sensitivity mass spectrometer are used to analyze isotopic abundances of rare gases from microgram samples of polished sections. The feasibility of the technique is demonstrated by the analysis of primordial helium and neon from the Kapoeta and Fayetteville meteorites. (Author)

A67-40312
OBSERVATION OF MOVING STRIATION MODES IN A GAS LASER.
G. Forgo and M. J. O. Strutt (Swiss Federal Institute of Technology, Dept. of Advanced Electrical Engineering, Zurich, Switzerland).
Electronics Letters, vol. 3, Sept. 1967, p. 423.

Observations of definitely periodic oscillations in the sidelight intensity of an He-Ne laser, which are thought to be caused by moving striations. The frequency of the striations is a function of the discharge current. The behavior of the striation frequency also shows hysteresis - i.e., the jumping point of the frequency is dependent on whether the current is decreasing or increasing. No influence of the laser action on the discharge current and on the striations could be measured. M.F.

A67-40321
A PASCHEN-BACK HYPERFINE FILTER FOR OPTICAL PUMPING.
K. Ernst, P. Minguzzi, and F. Strumia (Pisa, Università, Istituto di Fisica; Consiglio Nazionale delle Ricerche, Gruppo Nazionale di Struttura della Materia, Pisa, Italy).
Nuovo Cimento, vol. 51B, Sept. 11, 1967, p. 202-206.

Description of a filter operating on the principle of the Paschen-Back effect and capable of being used for any atom having a hyperfine doublet splitting. The best filtering conditions were obtained at a temperature of the absorption cell equal to 125°C and a field value of 8.3 kgauss. An investigation of the filtering action under conditions of wide-angle illumination revealed that the filtering ratio was the same as before, but the light collected was greater. The filter proved to combine good filtering efficiency and high luminosity. M.M.

A67-40351
RECENT DEVELOPMENTS IN COHERENT OPTICS TECHNOLOGY.
W. H. Culver (Institute for Defense Analyses, Washington, D.C.).
IN: SYMPOSIUM ON ELECTROMAGNETIC SENSING OF THE EARTH FROM SATELLITES, UNIVERSITY OF FLORIDA, CORAL GABLES, FLA., NOVEMBER 22-24, 1965, PROCEEDINGS. [A67-40350 22-14]
Symposium sponsored by the University of Miami, the American Geophysical Union, the American Meteorological Society, and the Optical Society of America.
Edited by Ralph Zirkind.
Brooklyn, N.Y., Polytechnic Press of the Polytechnic Institute of Brooklyn, 1967, p. A1-A3.

Brief discussion concerning several of the more recent and important achievements in coherent optics technology. The effective blackbody temperatures of six radiation sources are presented, and the output and pulse duration of four laser sources are tabulated. R.B.S.

A67-40357 *
ATMOSPHERIC SENSING WITH CO_2 LASERS.
Robert A. McClatchey and Robert H. Norton (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.).
IN: SYMPOSIUM OF ELECTROMAGNETIC SENSING OF THE EARTH FROM SATELLITES, UNIVERSITY OF FLORIDA, CORAL GABLES, FLA., NOVEMBER 22-24, 1965, PROCEEDINGS. [A67-40350 22-14]
Symposium sponsored by the University of Miami, the American Geophysical Union, the American Meteorological Society, and the Optical Society of America.
Edited by Ralph Zirkind.
Brooklyn, N.Y., Polytechnic Press of the Polytechnic Institute of Brooklyn, 1967, p. G1-G10. 11 refs.

The use of CO_2 lasers is suggested for investigation of planetary atmospheres containing significant amounts of CO_2. As an example, an experiment is described for an orbiting spacecraft wherein the varying Doppler shift of the laser beam permits the detailed measurement of a spectral line profile. The resolution is limited only by the frequency width of the laser emission. A line profile measurement of this type will allow a determination of surface pressure and the temperature of the lower atmosphere. (Author)

A67-40366
SATELLITE OBSERVATIONS USING RAMAN COMPONENT OF LASER BACKSCATTER.
John Cooney (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
IN: SYMPOSIUM ON ELECTROMAGNETIC SENSING OF THE EARTH FROM SATELLITES, UNIVERSITY OF FLORIDA, CORAL GABLES, FLA., NOVEMBER 22-24, 1965, PROCEEDINGS. [A67-40350 22-14]
Symposium sponsored by the University of Miami, the American Geophysical Union, the American Meteorological Society, and the Optical Society of America.
Edited by Ralph Zirkind.
Brooklyn, N.Y., Polytechnic Press of the Polytechnic Institute of Brooklyn, 1967, p. P1-P10.

Discussion of some aspects of the potential use of lasers in the remote determination of meteorological state parameters, with special emphasis on lasers mounted on satellites for probing the atmosphere below. The calculations made show that monitoring the frequency-shifted Raman component of the laser backscatter can lead to a determination of density, temperature, and composition, at least of the major components, as a function of altitude, and further that this can be done despite the presence of obscuring effects arising from aerosol scatter. P.v.T.

A67-40412 #
DETERMINATION OF THE OPTIMUM TRANSMISSION COEFFICIENT OF A LASER OUTPUT MIRROR [OPREDELENIE OPTIMAL'NOGO KOEFFITSIENTA PROPUSKANIIA VYKHODNOGO ZERKALA O.K.G.].
M. M. Drozdov and V. I. Matveev (Moskovskoe Vysshee Tekhnicheskoe Uchilishche, Moscow, USSR).
Pribory i Tekhnika Eksperimenta, July-Aug. 1967, p. 194-196. 10 refs. In Russian.

Development of an experimental technique for determining laser output power as a function of the transmission coefficient of the output mirror. A distinctive feature of the method is the use of a rotating plane-parallel wafer in the resonant cavity to vary the value of the laser total losses. V.P.

A67-40413 #
HIGH-CURRENT CONTINUOUS-OPERATION CATHODES FOR AN ARGON-ION LASER [SIL'NOTOCHNYE KATODY NEPRERYVNOGO DEISTVIIA DLIA LAZERA NA IONAKH ARGONA].
V. I. Donin, V. M. Klement'ev, and V. P. Chebotaev (Akademiia Nauk SSSR, Sibirskoe Otdelenie, Institut Fiziki Poluprovodnikov, Novosibirsk, USSR).
Pribory i Tekhnika Eksperimenta, July-Aug. 1967, p. 230, 231. In Russian.

Description of cold-emission hollow metal cathodes designed to produce high-current discharges at low working-gas pressures. The electron source is the spot produced by cathode sputtering owing to a self-sustained arc discharge. V.P.

A67-40414 #
UTILIZATION OF A CABLE-TYPE PULSE TRANSFORMER IN THE POWER-SUPPLY SYSTEM OF A GAS LASER [ISPOL'ZOVANIE KABEL'NOGO IMPUL'SNOGO TRANSFORMATORA V SISTEME PITANIIA GAZOVOGO O.K.G.].
A. S. Nasibov, A. A. Isaev, V. M. Kaslin, and G. G. Petrash (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).
Pribory i Tekhnika Eksperimenta, July-Aug. 1967, p. 232, 233. 5 refs. In Russian.

Description of a power-supply system for gas lasers, which consists of a two-piece coaxial cable and a pulse transformer with coaxial-cable windings. The system was found to possess all the characteristics required for gas-laser operation (such as voltages on the order of 50 kv). V.P.

A67-40415 #
RECORDING A SINGLE PULSE OF A Q-SWITCHED LASER BY MEANS OF A STORAGE TUBE [REGISTRATSIIA MONOIMPUL'SA LAZERA, RABOTAIUSHCHEGO V REZHIME S MODULIATSIEI DOBROTNOSTI, PRI POMOSHCHI ZAPOMINAIUSHCHEI TRUBKI].
B. M. Ashkinadze, V. M. Rysakov, I. M. Fishman, and I. D. Iaroshetskii (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR).
Pribory i Tekhnika Eksperimenta, July-Aug. 1967, p. 234, 235. In Russian.

Description of a technique which uses an oscillograph with a storage tube in combination with a low-inertia surface-barrier photodiode to visually record single nanosecond pulses from a Q-switched laser. The recording rate is on the order of 1000 km/sec, while the reproduction time ranges from 3 to 5 min. V.P.

A67-40469
WORKING WITH ETALONS.
Viktor Met (Electro Optics Associates, Palo Alto, Calif.).
Microwaves, vol. 6, Sept. 1967, p. 45-54. 7 refs.

Description of a Fabry-Pérot etalon resonator consisting of two parallel, mirrored optical flats. Optical planar waves reach the etalon at an angle to its surface normal. Multiple reflections occur between the mirrored surfaces and individual components and the waves will interfere at two points. A special study is made of the angles of incidence for which constructive interference occurs at one of these points, so that all components leaving this point add in phase. It is shown that, for such preferred directions, the components reflected from the other point destructively interfere and that actually all the incident energy is transmitted by the etalon. P.v.T.

A67-40485
OBSERVATIONS ON A CONCENTRIC SPHERICAL CAVITY LASER OSCILLATOR.
J. W. Strozyk (U.S. Army, Electronics Command, Electronics, Components Laboratory, Microwave and Quantum Electronics Branch, Fort Monmouth, N.J.).
IEEE Journal of Quantum Electronics, vol. QE-3, Aug. 1967, p. 343-348. 13 refs.

Experimental results on a number of ruby rods in concentric spherical cavities are presented and discussed. The observations include intensity variations (spiking) as a function of input energy, longitudinal and transverse mode structure, and output energy distribution. The characteristics of flat and concentric cavities are compared using the data presented. The spiking frequencies and decay times are compared with simple rate equation predictions during the quasi-CW time of operation with reasonable agreement. Results indicate that the cavity effects will be similar regardless of the type of laser material used. (Author)

A67-40487
NONLINEAR ABSORPTION OF LIGHT - OPTICAL SATURATION OF ELECTRONIC TRANSITIONS IN ORGANIC MOLECULES WITH HIGH INTENSITY LASER RADIATION.
C. R. Giuliano and L. D. Hess (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.).
IEEE Journal of Quantum Electronics, vol. QE-3, Aug. 1967, p. 358-367. 65 refs.
USAF-Army-supported research.

Review of the established photophysical properties of complex organic molecules and discussion of their relationship to the mechanism of optical bleaching of dyes. Experimental data are reported for the transmission of intense ruby laser radiation by several types of dyes. Rate-equation analyses are carried out, using steady-state solutions and iterative computer solutions; calculated bleaching curves are compared with the data obtained for cryptocyanine. On these bases, it is shown that, in general, the optical bleaching process involves the removal of ground-state molecules to other states having smaller absorption cross sections at the exciting frequency, and that recovery of absorption at this frequency is characterized by a complex relaxation mechanism. M.F.

A67-40488
NEAR INFRARED LASER TRANSITIONS IN PURE HELIUM.
Richard L. Abrams and George J. Wolga (Cornell University, Dept. of Electrical Engineering, Ithaca, N.Y.).
IEEE Journal of Quantum Electronics, vol. QE-3, Aug. 1967, p. 368.
ARPA-supported research.

Account of a new laser transition found in pure helium at λ_{air} = 1.8685 ± 0.0001 μ. This corresponds to the 4^3F-3^3D transition in helium. The wavelength was measured by interferometric comparison with the known 1.9543-μ transition in helium which can be made to oscillate simultaneously with the new line. The 1.9543-μ line corresponding to the transition 4^3P-3^3D was studied with a scanning Fabry-Pérot interferometer. An investigation was made to determine which fine structure components are upper laser levels. M.F.

A67-40489 *

OBSERVED LASER LINES IN FREON-HELIUM MIXTURES.

G. L. Trusty, P. K. Yin, and S. H. Koozekanani (Ohio State University, Dept. of Electrical Engineering, Electroscience Laboratory, Columbus, Ohio).

IEEE Journal of Quantum Electronics, vol. QE-3, Aug. 1967, p. 368. Research supported by the Ohio State University; Grant No. NsG-74-60.

Observation of ten laser lines from two Freon-helium mixtures in a CW gas discharge. Eight lines from an He-CCl_2F_2 mixture and two lines from an He-$CBrF_3$ mixture are noted and tabulated. The transitions corresponding to these lines are not identified. M.F.

A67-40490

NEW CW LASER WAVELENGTH IN KrII.

A. M. Johnson and C. E. Webb (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).

IEEE Journal of Quantum Electronics, vol. QE-3, Aug. 1967, p. 369.

Observation of CW laser oscillation at λ7525.5 Å in a dc-excited krypton discharge. The threshold current for oscillation with high-reflectivity mirrors in a water-cooled quartz discharge tube was 17 amp. Threshold optimum filling pressure was ~370 μ and optimum magnetic field ~175 gauss. A term assignment is proposed for a line in the spontaneous-emission spectrum of KrII at λ7525.48 Å, and evidence for the correctness of this assignment is given. M.F.

A67-40558 *

SPECTRAL DEPENDENCE OF DEEP-SPACE COMMUNICATIONS CAPABILITY.

John Dimeff, William D. Gunter, Jr., and Ronald J. Hruby (NASA, Ames Research Center, Moffett Field, Calif.).

IEEE Spectrum, vol. 4, Sept. 1967, p. 98-104. 14 refs.

Formulation of a simple model of space communications capability for the mid-1970s. The dependence of future developments in communications on the part of the frequency spectrum involved is examined. The model developed includes the effects of minimum power required to recognize a signal in the presence of noise and the effect of the anticipated state of the art in antenna design. The model suggests that the frequency regime that would allow maximum information transfer is in the portion of the spectrum centered about 10^{10} Hz, and that development of increased deep-space communications capability should be directed to production of operational systems in a band around this value. The analysis indicates that optical transmissions would be several orders of magnitudes poorer than rf technology. It is concluded that the suggestion that laser technology would be more efficient than rf technology should be more carefully assessed. R.L.

A67-40571 #

ACCURATE VELOCITY MEASUREMENTS BY MEANS OF A LASER INTERFEROMETER [MESURE PRECISE DES VITESSES AU MOYEN D'UN INTERFEROMETRE A LASER].

Jean-Pierre Taran (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France).

(Congrès Mesucora, Paris, France, Apr. 17-21, 1967, Communication.)
ONERA, TP no. 450, 1967. 9 p. 5 refs. In French.

Description of experiments involving velocity measurements of moving objects by means of a laser interferometer. This principle was successfully used in the measurement of atmospheric braking. The accuracy obtained during the experiments was only a few percent; however, it may attain 10^{-3} through a reasonable increase in the resolution power of the recorder and by the elimination of atmospheric and seismic disturbances. M.M.

A67-40692

STUDY OF THE RECOVERY TIME OF A CO_2 LASER EXCITED BY PULSE DISCHARGES [ETUDE DU TEMPS DE RECOUVREMENT DU LASER A GAZ CARBONIQUE EXCITE PAR DECHARGES IMPULSIONNELLES].

Alain Van Lerberghe, Gothom Arya, Monique Margottin-Maclou, and Lucien Henry (Paris, Université, Laboratoire de Spectroscopie Moléculaire, Paris, France).

Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 265, no. 6, Aug. 7, 1967, p. 359-362. 10 refs. In French.

Study of a CO_2 laser using a two-pulse electric excitation. The study showed that the power of the laser pulse produced by the second electric pulse depends on the time interval Δt between the two electric pulses. It is found that heat conduction toward the walls is an important process involved in the operation of CO_2 lasers. M.F.

A67-40709

THE SPHERICAL-MIRROR FABRY-PEROT RESONATOR AND ITS UTILITY IN SPECTRUM ANALYSIS [LE RESONATEUR PEROT-FABRY A MIROIRS SPHERIQUES ET SON UTILISATION EN ANALYSE SPECTRALE].

Jamal-Édine Abderrazik.

Annales des Télécommunications, vol. 22, Jan.-Feb. 1967, p. 41-60. 18 refs. In French.

Consideration of spherical-mirror resonators which, although possessing an open structure, also possess intrinsic modes, as in the case of cavities consisting of two plane parallel mirrors of infinite dimensions. The intrinsic modes of spherical-mirror resonators are defined, and the parameters which identify the beams generated by such resonators are described. A direct application of this theoretical study is discussed, dealing mainly with the utility of these resonators as analyzers of the spectrum of a laser beam. This spectral analysis raises problems, especially those of adaptation of the analyzer to the beam to be analyzed, and of injection of the beam into the analyzer. F.R.L.

A67-40724 #

EXPERIMENTAL INVESTIGATION OF THE TRANSFORMATION OF LASER RADIATION BY OPTICAL SYSTEMS [EKSPERIMENTAL'NOE ISSLEDOVANIE PREOBRAZOVANIIA LAZERNOGO IZLUCHENIIA OPTICHESKIMI SISTEMAMI].

K. Kelov (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR).

Akademiia Nauk Turkmenskoi SSR, Izvestiia, Seriia Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk, no. 4, 1967, p. 38-44. 5 refs. In Russian.

Experimental study of the variation of the cross section of a laser beam during propagation in free space and through optical systems. It is demonstrated that the radiation of an He-Ne laser at a wavelength of 6328 Å with a specific type of TEM_{00} oscillations represents a Gaussian beam. On the basis of the results and using the method of least squares, an empirical formula is derived which approximately describes the law of beam broadening during propagation through air. The theory of the transformation of a Gaussian beam by a single-lens system is substantiated by experimental results. The theory for transformation by a two-lens system close to a telescopic arrangement is qualitatively substantiated for inaccuracies of the telescopic alignment smaller than 1 cm. The interference effect increases with larger numbers of interface surfaces during propagation through an optical system causing a nonuniform distribution of intensity in the beam cross sections. T.M.

A67-40761

DYNAMICS OF NONLINEAR INTERACTION BETWEEN RADIATION AND MATTER.

H. Haken (Stuttgart, Technische Hochschule, Institut für theoretische und angewandte Physik, Stuttgart, West Germany).

IN: DYNAMICAL PROCESSES IN SOLID STATE OPTICS; TOKYO SUMMER LECTURES IN THEORETICAL PHYSICS, OISO, JAPAN, AUGUST 29-SEPTEMBER 3, 1966. PART 1. [A67-40756 23-26]
Lectures sponsored by the Japan Society for the Promotion of Science.
Edited by Ryogo Kubo and Hiroshi Kamimura.
Tokyo, Syokabō Publishing Co.; New York, W. A. Benjamin, Inc., 1967, p. 168-194. 45 refs.

Discussion of the production and properties of laser light. Fully quantum-mechanical laser equations which describe the interaction between radiation and an active material are derived, and the two-mode operation in a homogeneously broadened line is examined, including the cases where both modes are well below threshold, somewhat above or somewhat below threshold, and both above threshold. R.B.S.

A67-40762

QUANTUM THEORY OF NOISE IN MASERS AND LASERS.

M. Lax (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).

IN: DYNAMICAL PROCESSES IN SOLID STATE OPTICS; TOKYO SUMMER LECTURES IN THEORETICAL PHYSICS, OISO, JAPAN, AUGUST 29-SEPTEMBER 3, 1966. PART 1. [A67-40756 23-26]

Lectures sponsored by the Japan Society for the Promotion of Science.

Edited by Ryogo Kubo and Hiroshi Kamimura.

Tokyo, Syokabō Publishing Co.; New York, W. A. Benjamin, Inc., 1967, p. 195-245. 41 refs.

Detailed study of the theory of noise in lasers and masers, with emphasis on equations of motion and the fluctuation problem. In order to deal with the fluctuation problem, a number of definitions familiar in the theory of random processes are introduced, including a definition of the random process itself, conditional probability, the Markov process, and the Chapman-Kolmogorov condition. The derivation of the equation for the density matrix from the equation of motion of a general operator is illustrated in a simple quantum-mechanical case, and the construction of noise sources via the Einstein relation is presented by means of a block diagram. R.B.S.

A67-40783

SINGLE WAVELENGTH OPERATION OF A PULSED WATER-VAPOR LASER.

W. Q. Jeffers (Illinois, University, Dept. of Electrical Engineering, Electro-Physics Laboratory, Urbana, Ill.).

Applied Physics Letters, vol. 11, Sept. 15, 1967, p. 178-180. 7 refs.

USAF-supported research.

Single wavelength operation on 25 emission lines in the range 23 to 57 μ was obtained by using three diffraction gratings to make the laser resonator frequency-selective. This technique leads to new emission lines, enhanced output on weak lines, and identical pulse-to-pulse emission intensities. These results show that there are strong interactions among the transitions responsible for laser action. They are quantitatively consistent with the assumption that laser action is due to vibration-rotation transitions of the H_2O molecule. (Author)

A67-40784

EFFECT OF A HEATED PLATINUM WIRE ON A SEALED CO_2 LASER SYSTEM.

F. M. Taylor, A. Lombardo (Systems Research Laboratories, Inc., Dayton, Ohio), and W. C. Eppers (USAF, Systems Command, Research and Technology Div., Avionics Laboratory, Wright-Patterson AFB, Ohio).

Applied Physics Letters, vol. 11, Sept. 15, 1967, p. 180-182. 8 refs.

Contract No. AF 33(615)-67-C-1138.

A heated platinum wire was used in a sealed CO_2-N_2-He laser system, resulting in increases in output power that were dependent on the initial fill pressure of CO_2. The system was also filled with a CO_2-He mixture and made to lase. Heating of the platinum wire caused a decrease in output power. It was tentatively concluded that the platinum catalyzes the reaction $CO + O \rightarrow CO_2$, permitting a higher concentration of CO_2 in a sealed system than is otherwise possible. (Author)

A67-40786

NANOSECOND PULSE GENERATION BY MEANS OF STIMULATED BRILLOUIN SCATTERING.

A. J. Alcock and C. De Michelis (National Research Council, Div. of Pure Physics, Ottawa, Canada).

Applied Physics Letters, vol. 11, Sept. 15, 1967, p. 185, 186.

Single high-intensity pulses having a duration under 5 nsec have been generated by means of multiple stimulated Brillouin scattering (MSBS) from methanol. This was achieved by placing a liquid cell at one end of a giant-pulse ruby laser cavity and a Fabry-Pérot etalon at the other. Laser oscillation builds up at a wavelength where the Fabry-Pérot provides a high reflectivity, and MSBS occurs until the wavelength is shifted to a point at which the Fabry-Pérot has a transmission maximum, thus allowing a single pulse of scattered radiation to be coupled out. (Author)

A67-40789

INTERPRETATION OF THE CS_2 LASER TRANSITIONS.

Arthur G. Maki (National Bureau of Standards, Washington, D.C.).

Applied Physics Letters, vol. 11, Sept. 15, 1967, p. 204, 205. 8 refs.

AEC-supported research.

Examination of the observed and calculated laser transitions for CS_2. The N_2-CS_2 lines are identified as P-branch transitions with J = 28 to 46 for the 001-100 vibrational transition. A population ratio of $N_{001}/N_{100} = 1.07$ is determined for the system, assuming a temperature of 300°K. The mechanism for selectively populating the 001 level of CS_2 is discussed. R.B.S.

A67-40876

REDUCTION OF THE SUSCEPTIBILITY TO OPTICALLY INDUCED INDEX INHOMOGENEITIES IN $LiTaO_3$ AND $LiNbO_3$.

H. J. Levinstein, A. A. Ballman, R. T. Denton, A. Ashkin, and J. M. Dziedzic (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).

Journal of Applied Physics, vol. 38, July 1967, p. 3101, 3102.

It has been established that $LiTaO_3$ can be made resistant to laser-induced inhomogeneities in the index of refraction at power levels as high as 500 watts/cm^2. This is accomplished by annealing $LiTaO_3$ in an electric field of 250 v/cm at a temperature of 700°C for 1/2 hr and then cooling the crystal to room temperature with the field on at a rate of 100°C/hr. The susceptibility to laser-induced index changes in $LiNbO_3$ is reduced by this treatment, but not to the same extent as in $LiTaO_3$. A mechanism is proposed to explain the observed reduction in susceptibility to damage. (Author)

A67-40877

DIRECTIONAL CHARACTERISTICS IN OPTICAL HETERODYNE DETECTION PROCESSES. II.

Vincent J. Corcoran (Martin Marietta Corp., Martin Co., Aerospace Div., Electromagnetics Laboratory, Orlando, Fla.).

Journal of Applied Physics, vol. 38, July 1967, p. 3117-3122.

The variation in the ac output current in a coherent optical-detection process as a function of orientation has previously been analyzed for point sources. This work is extended by the author to include finite sources, finite bandwidth, random-phase sources, and rough surfaces. The general expression for two finite sources in the Fraunhofer region indicates that the directivity is the product of the radiation patterns of the individual sources multiplied by the directivity of the detector due to point sources. For typical lasers the bandwidths are so narrow that the directivity is practically unaffected by the finite width. "White" surfaces are shown to be equivalent to uniform surfaces with a random phase which is statistically independent from point to point. These surfaces are shown to have effectively the same directivity as far-field point sources. (Author)

A67-40883

TRANSIENT INTERFERENCE STUDIES OF EMISSION FROM A PULSED RUBY LASER.

David A. Berkley and George J. Wolga (Cornell University, Ithaca, N.Y.).

(Rochester Conference on Coherence and Quantum Optics, 2nd, Rochester, N.Y., June 22-24, 1966, Paper.)

Journal of Applied Physics, vol. 38, July 1967, p. 3231-3241. 14 refs.

ARPA-supported research.

A transient interference experiment has been performed, using the radiation from a normally spiking, pulsed ruby-laser oscillator. In the experiment the laser output at time t is made to interfere with emission corresponding to an earlier time, t-τ, by means of an optical delay inserted into a two-pinhole Young's interferometer. A light-pipe photomultiplier oscilloscope system permits photographic recording of the interference fringes during a single spike of the laser emission, with a time resolution of less than 15 nsec. From

the data obtained both the fringe visibility and the relative pattern phase of the interference pattern may be evaluated. Data are presented for both visibility and pattern phase for several delay times. The principal observation is that during a single laser spike the frequency increases with time. An analysis of the experiment and of possible causes for frequency variation of the laser with time results in the hypothesis that there is lattice strain in the ruby associated with the optical pumping to the excited state from which laser emission occurs. Linearity is assumed between strain and the number of excited ions. This permits a calculation to be made of the frequency change resulting from the strain, and very reasonable agreement is obtained upon comparison with experiment. The visibility data are discussed, but quantitative conclusions cannot be drawn. (Author)

A67-40891

OPTICAL MIXING IN THE ATOMIC STATES OF A He:Ne LASER.

B. E. Cherrington and J. T. Verdeyen (Illinois, University, Dept. of Electrical Engineering, Urbana, Ill.).

Journal of Applied Physics, vol. 38, July 1967, p. 3401, 3402. 10 refs.
Contract No. AF 33(615)-5248.

Description of the optical mixing of two low-level 3.39-μ signals in the atomic states of an He-Ne laser. This mixing resulted in the amplitude modulation of the visible laser output at the difference frequency between the two injected signals. The apparatus used in the experiment is shown. It is shown that there is an exact one-to-one correspondence between the rate of intensity modulation of the visible laser line emission and the difference frequency between the two 3.39-μ signals injected into the visible laser. In the experiments performed, this exact correspondence was observed from very low difference frequencies up to a frequency of at least 1 MHz. M.M.

A67-40893

RESONATOR MODES AND SPLITTING OF THE 0.337-MM EMISSION OF THE CN LASER.

H. Steffen, J.-F. Moser, and F. K. Kneubühl (Eidgenössische Technische Hochschule, Laboratorium für Festkörperphysik, Zurich, Switzerland).

Journal of Applied Physics, vol. 38, July 1967, p. 3410, 3411. 6 refs.
Research supported by the Eidgenössische Kommission zur Förderung der Forschung.

Investigation, by two means, of the problem of deciding if modes of one or more laser emissions with similar wavelength are present. Firstly, a given equation relates the wavelength to the resonance length of the laser resonator with circular plane mirrors for a certain mode, and, secondly, an external metallic-mesh Fabry-Pérot interferometer permits direct observation of the line splittings. F.R.L.

A67-40894

GAS-DISCHARGE LASER DETECTOR.

H. Jacobs (U.S. Army, Electronics Command, Electronic Components Laboratory, Fort Monmouth, N.J.), A. J. Kerecman (U.S. Army, Electronics Command, Institute for Exploratory Research, Fort Monmouth, N.J.), and J. Schumacher (Monmouth College, West Long Branch, N.J.).

Journal of Applied Physics, vol. 38, July 1967, p. 3412, 3413. 5 refs.

Description of a physical effect which may be useful in providing a detector for 10.6-μ laser radiation, with medium levels of power and less than millisecond time responses. If a laser beam is transmitted through a glow-discharge tube, the current through the tube is found to change and is of such magnitude that it may provide a useful measurement of the radiation intensity. It is suggested that a glow discharge may be used as a detection device for measuring laser output in the region of 10.6 μ or other far-IR wavelengths. P.v.T.

A67-40895

A LASER-INDUCED INHOMOGENEITY OF REFRACTIVE INDICES IN KTN.

F. S. Chen (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).

Journal of Applied Physics, vol. 38, July 1967, p. 3418-3420.

Description of measurements made on the indices of refraction near damaged spots in KTN (potassium tantalate niobate). In the case of KTN, such a distortion (referred to as "damage," even though no mechanical damage occurs and the effects are reversible) occurs only when the laser beam and a dc electric field are simultaneously present; the distortion fades away in a few hours at room temperature. A plausible cause for this distortion effect is discussed. P.v.T.

A67-40902

MICHELSON INTERFEROMETER USED AS A TUNABLE MIRROR IN LASER RESONATORS.

K. Kantor, A. Kiss, and T. Salamon (Hungarian Academy of Sciences, Central Research Institute of Physics, Budapest, Hungary).

(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, Feb. 1967, p. 342, 343.)
Soviet Physics - JETP, vol. 25, Aug. 1967, p. 221, 222. Translation.

Consideration of the Michelson interferometer as a tunable mirror, the reflectivity and transmission of which depend on the optical lengths of the interferometer arms and on the wavelength. When one of the reflecting mirrors of a laser is replaced by the interferometer, internal modulation of the initial intensity is obtained. F.R.L.

A67-40903

LASER MODE SYNCHRONIZATION BY DIELECTRIC CONSTANT MODULATION.

L. N. Magdich.

(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, Feb. 1967, p. 344-349.)
Soviet Physics - JETP, vol. 25, Aug. 1967, p. 223-226. 7 refs. Translation.

The radiation characteristics are investigated for a gas laser where the dielectric constant of an electro-optical crystal mounted inside the resonator is modulated at a frequency close to that of intermode beats. It is shown that, depending on the modulating voltage, the mode distribution of radiation intensity is determined chiefly either (1) by the modulating voltage or (2) by the properties of the laser's active medium. The second case is considered in the present paper. Mode interaction due to Q switching of the laser resonator and mode interaction to dielectric constant modulation are compared. (Author)

A67-40907

CONDITIONS FOR SELF EXCITATION OF A LASER OPERATING IN AN INHOMOGENEOUSLY BROADENED BAND.

N. S. Belokrinitskii, V. L. Broude, V. I. Kravchenko, A. D. Manuil'skii, N. F. Prokopiuk, and M. S. Soskin (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki, Kiev, Ukrainian SSR).

(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, Feb. 1967, p. 424-433.)
Soviet Physics - JETP, vol. 25, Aug. 1967, p. 276-282. 10 refs. Translation.

Analysis of the threshold characteristics of a laser with a tunable selective resonator. The results of measurements and computation of generation frequencies and threshold pumping are given for a neodymium laser with a continuously tunable frequency within the 9434 cm^{-1} band. It is shown that the basic characteristics of stimulated emission at the threshold of generation are determined by the shape of the luminescence band of the active medium and the Q-factor curve of the selective resonator. (Author)

A67-40908

SELF-SYNCHRONIZATION OF AXIAL MODES IN A LASER WITH SATURABLE FILTERS.

T. I. Kuznetsova, V. I. Malyshev, and A. S. Markin (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).

(Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, vol. 52, Feb. 1967, p. 438-446.)
Soviet Physics - JETP, vol. 25, Aug. 1967, p. 286-291. 6 refs. Translation.

Experimental and theoretical investigation of ff oscillations (with periods of 7, 14, and 22 nsec) of the intensity of the giant pulse of a laser with saturable filters at different filter positions inside of the cavity. The theoretical results are found to agree with the observed dependence of the structure of the giant pulse on the filter coordinate. M.F.

A67-40916
THE LASER GYRO.
Joseph Killpatrick (Honeywell, Inc., Minneapolis, Minn.).
IEEE Spectrum, vol. 4, Oct. 1967, p. 44-55. 47 refs.

Description of the laser gyro, which combines the properties of the optical oscillator, the laser, and general relativity to produce an integrating rate gyroscope. This gyro measures rotation in inertial space, but does not use a spinning mass as conventional gyros do. Because of the absence of spinning mass, the gyro's performance is not affected by accelerations, and it can sense very high rates with great accuracy. Other important advantages of the laser gyro are lack of special cooling, low-power consumption, and simplicity of construction. M.F.

A67-40935
MICROINHOMOGENEITIES OF THE IMPURITY DISTRIBUTION IN HEAVILY DOPED GALLIUM ARSENIDE.
G. P. Proshko and V. I. Shveikin.
(Fizika i Tekhnika Poluprovodnikov, vol. 1, Apr. 1967, p. 514-518.)
Soviet Physics - Semiconductors, vol. 1, Oct. 1967, p. 427-430.
6 refs. Translation.
[For abstract see issue 14, page 2368, Accession no. A67-28528]

A67-40941
MECHANISM OF GENERATION OF LASER RADIATION IN CdS_x-$CdSe_{1-x}$ CRYSTALS IN THE CASE OF TWO-PHOTON EXCITATION.
M. S. Brodin, S. V. Zakrevskii, V. S. Mashkevich, and V. Ia. Reznichenko (Akademiia Nauk Ukrainskoi SSR, Institut Fiziki, Kiev, Ukrainian SSR).
(Fizika i Tekhnika Poluprovodnikov, vol. 1, Apr. 1967, p. 595-597.)
Soviet Physics - Semiconductors, vol. 1, Oct. 1967, p. 495-497.
Translation.
[For abstract see issue 14, page 2331, Accession no. A67-28534]

A67-40964
TWO-PHOTON LASER EXCITATION OF POLYCYCLIC AROMATIC MOLECULES.
Mark W. Dowley, Kenneth B. Eisenthal, and Warner L. Peticolas (International Business Machines Corp., Research Laboratory, San Jose, Calif.).
(American Chemical Society, National Meeting, 152nd, New York, N.Y., Sept. 11-16, 1967, Paper.)
Journal of Chemical Physics, vol. 47, Sept. 1, 1967, p. 1609-1619.
18 refs.

Extension of the theory of two-photon absorption to include vibronic mixing between electronic states. Theoretical expressions are derived which relate the possible transition pathways with measured quantities. The experimentally determined quantities are: the relative absorption cross sections of linearly vs circularly polarized exciting light, and the polarization of the fluorescence resulting from two-photon excitation by linearly polarized light. The theory is applied to measurements on two molecules of D_{2h} symmetry, anthracene and 9,10 dichloroanthracene. Utilizing the equations developed, the relative contributions of three pathways - (1) both photons absorbed along the short axis, (2) both photons absorbed along the long axis, and (3) one photon absorbed along the long axis and the other photon absorbed along the short axis - are determined. From the deduced values of the transition pathways the relative contributions of different final vibronic states to the absorption of two laser photons ($\hbar\omega$ = 14,400 cm^{-1}) are determined. P.v.T.

A67-41021
INTERNATIONAL CONGRESS ON LASER APPLICATIONS, 1ST, PARIS, FRANCE, JULY 18-23, 1967, REPORTS [CONGRES INTERNATIONAL SUR LES APPLICATIONS DES LASERS, 1ST, PARIS, FRANCE, JULY 18-23, 1967, COMMUNICATIONS].
Lasers, no. 7, 1967. 80 p. In English and French.

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A MOBILE LASER TRANSCEIVER USED FOR DETECTING LONG RANGE, SLOW VELOCITY, AND LOW DENSITY TARGETS. M. J. Laundry and J. R. Lochner, p. 5. [See A67-41022 23-16]

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AIRPORT GLIDE SLOPE VISUAL RANGE INDICATOR. E. T. Gerry and D. A. Leonard (Avco Corp., Everett, Mass.), p. 47, 48. 6 refs. [See A67-41027 23-14]

A COMPACT, AIR-TO-GROUND LASER RANGEFINDER. Paul E. Seeley and Ross Whistler (Radio Corporation of America, Burlington, Mass.), p. 57-62. [See A67-41028 23-14]

INFRARED-LASER RANGEFINDER. Ir. T. Bakker (National Defence Research Organization T.N.O., Hague, Netherlands), p. 63-67. 10 refs. [See A67-41029 23-14]

PULSE REGENERATIVE AMPLIFICATION IN THE ARGON-ION LASER. W. W. Simmons and R. S. Witte (TRW Systems Group, Redondo Beach, Calif.), p. 73-77. 10 refs. [See A67-41030 23-16]

MEASUREMENTS OF CHANGES IN LENGTH OF 10^{-11} CM BY OPTICAL HETERODYNING. H. Boersch, H. Eichler, G. Herziger, H. Lindner, and H. Makosch (Berlin, Technische Universität, Berlin, West Germany), p. 78-80. [See A67-41031 23-16]

A67-41022 #
A MOBILE LASER TRANSCEIVER USED FOR DETECTING LONG RANGE, SLOW VELOCITY, AND LOW DENSITY TARGETS.
M. J. Laundry and J. R. Lochner.
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 7, 1967, p. 5.

Discussion of a real-time technique for determining the atmospheric function, in which a retroreflector in the proximity of the target is used to measure the effect of the atmosphere on the laser beam. This information is then used to deduce the data reflected from the target. A second-generation laser transceiver has proven to be capable of detecting reflections from 2.5-in. retroreflectors at distances on the order of 25 mi and elevation angles of less than 10^{o}. V.P.

A67-41023 #
ON THE PROPER USE OF LASER RADIATION IN THE CALIBRATION OF SPECTROMETER SCANNING FUNCTIONS.
Louis Sica (Johns Hopkins University, School of Engineering Science, Laboratory of Astrophysics and Physical Meteorology, Baltimore, Md.).
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 7, 1967, p. 7-15. 23 refs.
Contracts No. Nonr-4010(14); No. AF 19(628)-4971.

Theoretical and experimental investigation showing that in order to use laser radiation to calibrate spectrometer scanning functions, it is necessary to duplicate (at the entrance slit) the spatial coherenc characteristics of radiation, derived originally from an incoherent source (such as a Globar). The relevant formulations from the literature of partial coherence theory are outlined, together with some new results to provide a unified treatment and facilitate experimental solutions of the problem. The major theoretical findings have been confirmed experimentally. V.P.

A67-41024
A LINEARIZED THEORY OF LASER-INDUCED INSTABILITIES IN LIQUIDS AND GASES.
Keith A. Brueckner and Siebe Jorna.
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 7, 1967, p. 16-26. 27 refs.
Contract No. DA-31-124-ARO(D)-257.

Derivation of a set of coupled equations relating the physical variables of the optical radiation and the fluid. The equations are linearized, and the existence of a differential operator acting on the variables is deduced formally from a consistency criterion. The Green's function is determined, and the nature of its singularities is examined. The analysis is illustrated by detailed calculations performed for carbon disulphide. With respect to gas lasers, the general expressions for the spatial and temporal gains are derived and are applied to the case of air. V.P.

A67-41025 #
SELECTION OF EMISSION WAVELENGTHS IN LASERS.
Erhard Max (Internationale Büro-Maschinen Gesellschaft mbH, Sindelfingen, West Germany).
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 7, 1967, p. 31-36. 5 refs.

Discussion of methods of isolating one out of several emission lines of a multicolor-emission noble-gas laser. It is shown that selection of emission wavelengths can be accomplished by polarization control of the emission inside the resonant cavity. The linear polarization states of all emission wavelengths are dispersed by an optical component, and one of these emission wavelengths is converted back to its linear polarization state through the action of an electro-optical phase plate. Two types of polarization dispersers are examined: (1) dispersion of the linear to elliptical polarization states (the ellipticity varying with the wavelength) by a quartz phase plate, and (2) rotary dispersion of linear polarization states by an optically active quartz crystal. V.P.

A67-41026 #
GALLIUM ARSENIDE LASERS IN OPTICAL SYSTEMS.
William L. Soper (U.S. Army, Materiel Command, Harry Diamond Laboratories, Washington, D.C.).
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 7, 1967, p. 44-46.

Discussion of four system models based on gallium-arsenide laser techniques, for measuring SNRs under various conditions. Each model uses a separate transmitter and receiver and is of a breadboard nature, which simplifies the evaluation of potentially useful components. By using these model systems in the evaluation of proposed military and nonmilitary systems, it proved possible to eliminate the need of reverting to the fundamental range equations. The results of SNR measurements performed for a variety of targets under different daylight conditions using an 85-kHz display are tabulated for a laser peak output power of 1 watt. V.P.

A67-41027 #
AIRPORT GLIDE SLOPE VISUAL RANGE INDICATOR.
E. T. Gerry and D. A. Leonard (Avco Corp., Avco-Everett Research Laboratories, Everett, Mass.).
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 7, 1967, p. 47, 48. 6 refs.

Description of a glide-slope transmissometer (which is essentially an optical radar in which the receiver is gated on to receive signals from only a specified range interval and is tuned to a wavelength other than the transmitted wavelength). The device measures the two-way transmission through the atmosphere between the receiver and a light source of known intensity situated at a known distance from the receiver. The light source is a laser emitting a short pulse of monochromatic light in the direction where the visibility is to be measured. The receiver is a gated photodetector tuned to the light wavelength corresponding to vibrational Raman scattering of the incident laser beam from a component of air. The time delay before the receiver is gated on specifies the range at which the measured scattering occurs. V.P.

A67-41028 #
A COMPACT, AIR-TO-GROUND LASER RANGEFINDER.
Paul E. Seeley and Ross Whistler (Radio Corporation of America, Burlington, Mass.).
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 7, 1967, p. 57-62.

Description of a compact laser developed especially for installation in the nose section of a helicopter. The device will provide continuous air-to-ground slant range data for obstacle avoidance, glide slope computations (time to touchdown), navigational fixing, terrain-following procedures, and ballistic computations associated with aircraft-carrier armaments. The advantages of a laser over a radar in the performance of these functions are outlined. V.P.

A67-41029
INFRARED-LASER RANGEFINDER.
Ir. T. Bakker (National Defence Research Organization T.N.O., Physics Laboratory, Hague, Netherlands).
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 7, 1967, p. 63-67. 10 refs.

Description of a rangefinder employing a Q-switched neodymium-glass laser to produce a single pulse with a peak power of 1 Mw and a rise time of 20 nsec. The pumping power is 55 joules. The performance of the rangefinder under various visual (range) and atmospheric (fog, rain, snow) conditions is examined, and its advantages over an equivalent ruby laser are noted. V.P.

A67-41030 #
PULSE REGENERATIVE AMPLIFICATION IN THE ARGON-ION LASER.
W. W. Simmons and R. S. Witte (TRW Systems Group, Redondo Beach, Calif.).
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 7, 1967, p. 73-77. 10 refs.

Theoretical and experimental investigation showing that a sequentially Q-switched argon-ion laser can operate as a pulsed regenerative amplifier-oscillator during its characteristic buildup time to saturation. The buildup time is defined by the cavity losses, and laser operation in this regime is similar to that of a mode-locked laser in that it involves an optical pulse reflected repeatedly between the mirrors. At the steady-state power level, saturation effects associated with the fluorescence line characteristics lead to laser pulse distortions. This mode of laser operation is shown to lend itself to satisfactory description by Lamb's semiclassical theory. V.P.

A67-41031 #
MEASUREMENTS OF CHANGES IN LENGTH OF 10^{-11} CM BY OPTICAL HETERODYNING.
H. Boersch, H. Eichler, G. Herziger, H. Lindner, and H. Makosch (Berlin, Technische Universität, I. Physikalisches Institut, Berlin, West Germany).
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 7, 1967, p. 78-80.

Discussion of a device which uses two He-Ne lasers operating at 0.63 μ to measure small changes in mirror spacing by optical heterodyning. The smallest measurable change is found to equal 10^{-3} Å. The application of the device to the investigation of the characteristics of piezoelectric materials is examined. V.P.

A67-41034
INTERNATIONAL CONGRESS ON LASER APPLICATIONS, 1ST, PARIS, FRANCE, JULY 18-23, 1967, REPORTS [CONGRES INTERNATIONAL SUR LES APPLICATIONS DES LASERS, 1ST, PARIS, FRANCE, JULY 18-23, 1967, COMMUNICATIONS].
Lasers, no. 8, 1967. 62 p. In English and French.

CONTENTS:

ION EMISSION FROM METAL SURFACE IRRADIATED BY GIANT-PULSE LASER BEAM. Susumu Namba, Pil Hyon Kim, Takashi Itoh, Tsutomu Arai (Institute of Physical and Chemical

Research, Tokyo, Japan), and Helmut Schwarz (Rensselaer Polytechnic Institute of Connecticut, Inc., East Windsor Hill, Conn.), p. 113-116. 10 refs. [See A67-41035 23-16]

GENERATION OF SHORT AND INTENSIVE LIGHT PULSES BY SATURABLE ABSORBERS. H. Boersch, H. Eichler, A. Schmackpfeffer, and H. Weber (Berlin, Technische Universität, Berlin, West Germany), p. 117-119. [See A67-41036 23-16]

MEASUREMENT OF THE DISTANCE TO THE MOON AND POSSIBILITIES OF INVESTIGATION ON THE ASTROMETRIC PARAMETERS OF THE EARTH-MOON SYSTEM BY THE METHOD OF LASER LOCATION. Iu. L. Kokurin, V. V. Kurbasov, V. F. Lobanov, A. N. Sukhanovskii, and N. S. Chernich (Akademiia Nauk SSSR, Moscow, USSR), p. 125-128. 5 refs. [See A67-41037 23-30]

A TUNABLE, TWO FREQUENCY OUTPUT, GIANT PULSE RUBY LASER. D. J. Bradley (Belfast, Queen's University, Belfast, Northern Ireland), G. Magyar (London, University, Englefield Green, Surrey, England), and M. C. Richardson (United Kingdom Atomic Energy Authority, Culham, Berks., England), p. 133, 134. 6 refs. [See A67-41038 23-16]

A BROAD BANDWIDTH DIGITAL LASER COMMUNICATION SYSTEM. J. H. Ward (International Telephone and Telegraph Corp., San Fernando, Calif.), p. 135, 136. [See A67-41039 23-07]

PERFORMANCE LIMITS AND DESIGN PROCEDURE FOR ALL-WEATHER TERRESTRIAL RANGEFINDERS. R. A. Kaplan and R. T. Daly (Control Data Corp., Melville, N.Y.), p. 137-143. 9 refs. [See A67-41040 23-14]

A67-41035 #

ION EMISSION FROM METAL SURFACE IRRADIATED BY GIANT-PULSE LASER BEAM.

Susumu Namba, Pil Hyon Kim, Takashi Itoh, Tsutomu Arai (Institute of Physical and Chemical Research, Tokyo, Japan), and Helmut Schwarz (Rensselaer Polytechnic Institute of Connecticut, Inc., Hartford Graduate Center, East Windsor Hill, Conn.).

(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)

Lasers, no. 8, 1967, p. 113-116. 10 refs.

Research supported by the Japan Society for Promotion of Science.

Experimental determination of the temperature of a metal surface irradiated by a giant-pulse laser beam by measurement of the energy of the emitted thermal ions. The peak power of a giant-pulse produced by using a rotating-prism method was 3 to 11 Mw and the pulse width was approximately 50 nsec. Details of the experimental arrangement are given together with a formula used for determining the ion energy at the target-metal surface on the basis of measured values for the time of flight of the ions from the target to the collector. Typical measurements of the ion energy are discussed and the relationship between ion energy and laser intensity is plotted. Two types of experiments involving ion emission in a magnetic field were performed using a tantalum target. They consisted of the application of a variable magnetic field parallel and perpendicular to the impact surface at constant laser intensity. Results are given in terms of ion emission in each magnetic field. T.M.

A67-41036

GENERATION OF SHORT AND INTENSIVE LIGHT PULSES BY SATURABLE ABSORBERS.

H. Boersch, H. Eichler, A. Schmackpfeffer, and H. Weber (Berlin, Technische Universität, I. Physikalisches Institut, Berlin, West Germany).

(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)

Lasers, no. 8, 1967, p. 117-119.

Description of a mechanism for the formation of very short ruby-laser light pulses and for controlling the pulse repetition frequency using mode-locking with saturable absorbers. The repetition frequency is varied by appropriate positioning of the absorber within the laser cavity. The highest frequency achieved was 1.26 GHz. Results of experimental study of the mode-locking mechanism are described. T.M.

A67-41037

MEASUREMENT OF THE DISTANCE TO THE MOON AND POSSIBILITIES OF INVESTIGATION ON THE ASTROMETRIC PARAMETERS OF THE EARTH-MOON SYSTEM BY THE METHOD OF LASER LOCATION.

Iu. L. Kokurin, V. V. Kurbasov, V. F. Lobanov, A. N. Sukhanovskii, and N. S. Chernich (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR).

(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)

Lasers, no. 8, 1967, p. 125-128. 5 refs.

Description of the considerations involved in accurate determination of the moon-earth distance by laser ranging, together with an evaluation of the possibility ot determining the parameters of the moon-earth system by laser ranging. Two difficulties involved in determining the moon's distance are examined. It is demonstrated that the lack of sufficient energy in contemporary lasers makes it impossible to measure the distance by the single-pulse measurement. Beam scattering at atmospheric inhomogeneities and problems caused by the moon's spherical shape are considered. The design of an artificial reflector to be delivered to the moon to alleviate these difficulties is described. The determination of the distance to a specific point on the lunar surface is described in terms of its significance in determining certain parameters of the earth-moon system. Equations are given for specifying these parameters on the basis of the ranging measurements, and the requirements posed by the technique are evaluated. T.M.

A67-41038 #

A TUNABLE, TWO FREQUENCY OUTPUT, GIANT PULSE RUBY LASER.

D. J. Bradley (Belfast, Queen's University, Belfast, Northern Ireland), G. Magyar (London, University, Royal Holloway College, Englefield Green, Surrey, England), and M. C. Richardson (United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Culham Laboratory, Culham, Berks., England).

(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)

Lasers, no. 8, 1967, p. 133, 134. 6 refs.

Description of the operation of a giant-pulse ruby laser having a tunable two-frequency output together with the results of spectral measurements conducted with the instrument. Simultaneous dual-frequency output operation of the laser system is achieved by utilizing the wavelength variation of the peak of the R_1 fluorescence line with temperature. This varies typically from 6958 Å at 500°K to 6934 Å at 77°K and the required wavelength separation is obtained by differentially refrigerating the two ruby rods used in the system. Spectral measurements were made with a 0.3 mm separation plane Fabry-Pérot interferometer and simultaneous temporal modulation of the spatially integrated output was recorded with a biplanar photodiode-Tektronix 519 system. To ascertain the degree of simultaneity within a pulse, Fabry-Pérot fringes were streak photographed with a high-speed image converter camera. Typical results of the measurements are given and their significance is discussed. T.M.

A67-41039

A BROAD BANDWIDTH DIGITAL LASER COMMUNICATION SYSTEM.

J. H. Ward (International Telephone and Telegraph Corp., ITT Federal Laboratories Div., San Fernando, Calif.).

(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)

Lasers, no. 8, 1967, p. 135, 136.

Brief description of a laser communication system which is capable of handling digital data at a 30-Mbit rate utilizing a pulse-coded polarization modulation scheme and a binary-detector arrangement. Both an analysis of the optical communication link and experimental performance data are included. A block diagram of the system is discussed, and the transmitting, modulating, and receiving components are described. T.M.

A67-41040
PERFORMANCE LIMITS AND DESIGN PROCEDURE FOR ALL-WEATHER TERRESTRIAL RANGEFINDERS.

R. A. Kaplan and R. T. Daly (Control Data Corp., TRG Div., Melville, N.Y.).
(Congrès International sur les Applications des Lasers, 1st, Paris, France, July 18-23, 1967, Communication.)
Lasers, no. 8, 1967, p. 137-143. 9 refs.

Analysis of the worst-case performance limits of a laser rangefinder for the purpose of determining the design procedure for a rangefinder capable of operation under all-weather conditions. The dependence of the echo signal and backscatter noise on range is studied, and the necessity for a time-programed receiver gain (TPG) as a function of range is described. The generation of the optimum TPG is examined using appropriate statistics because of the quantized nature of the detection process. It is shown that with a fixed TPG characteristic there exists a minimum all-weather operational range which is related to target and atmosphere constants only and is independent of the laser properties. Examples of the optimum characteristics are developed and a particularly simple means of generating a performance curve is described. Experimental results with actual laser rangefinders are given which verify the analytical approach. T.M.

A67-41049
LASER SAFETY; BRITISH OCCUPATIONAL HYGIENE SOCIETY, SYMPOSIUM ON PROTECTION AGAINST THE DANGERS OF LASER RADIATION, LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, LONDON, ENGLAND, NOVEMBER 7, 1966, PAPERS.
Annals of Occupational Hygiene, Supplement, July 1967. 77 p.

CONTENTS:

A67-41050
APPLICATION OF LASERS.

D. W. Goodwin (Ministry of Technology, Royal Radar Establishment, Great Malvern, Worcs., England).
(British Occupational Hygiene Society, Symposium on Protection Against the Dangers of Laser Radiation, London School of Hygiene and Tropical Medicine, London, England, Nov. 7, 1966, Paper.)
Annals of Occupational Hygiene, Supplement, July 1967, p. 23-29.

Review of laser applications as a research tool and for ranging and metrology. A brief up-to-date survey is given of those lasers which are currently available. Details of the performance of certain commercially used lasers include threshold and maximum power as well as operating wavelength. The application of gas lasers in interferometry is outlined together with a description of the Twyman-Green interferometer. The study of the Raman scattering effect is discussed in view of the resulting information about the phonon spectra of a solid. The principles of long-distance ranging by laser are described, and the extent of noise limitation is examined. T.M.

A67-41051
LASERS AND THE EYE.

J. Mellerio (London, University and Moorfields Eye Hospital, Institute of Ophthalmology, Dept. of Physiological Optics, London, England).
(British Occupational Hygiene Society, Symposium on Protection Against the Dangers of Laser Radiation, London School of Hygiene and Tropical Medicine, London, England, Nov. 7, 1966, Paper.)
Annals of Occupational Hygiene, Supplement, July 1967, p. 31-39; Discussion, p. 40, 41. 25 refs.

A brief description of laser light is followed by an explanation of how the ruby laser is useful to ophthalmic surgery. The interaction of laser light with tissues is discussed with particular attention to simple absorption and heating which are seen as the main factors in retinal damage. The explosive nature of pulsed laser damage is mentioned. The effects of lasers other than ruby are examined for their surgical use and their degree of hazard, and criteria for determining threshold damage are considered. (Author)

A67-41052
THE DERIVATION OF MAXIMUM PERMISSIBLE EXPOSURES TO LASER RADIATION.

J. M. Flood (Ministry of Technology, Royal Aircraft Establishment, Weapons Dept., Farnborough, Hants., England).
(British Occupational Hygiene Society, Symposium on Protection Against the Dangers of Laser Radiation, London School of Hygiene and Tropical Medicine, London, England, Nov. 7, 1966, Paper.)
Annals of Occupational Hygiene, Supplement, July 1967, p. 47-53. 5 refs.

Determination of the safe areas or safety contours in laser experiments both at short laboratory ranges and long ranges through the atmosphere on the basis of the maximum permissible energy density incident on the retina. The two cases of direct and indirect viewing are considered. It is demonstrated that the maximum permissible incident energy density on the pupil depends on the size of the image formed by the laser beam on the retina. Formulas are given for calculating whether a laser can be viewed safely either directly or indirectly. A wide variation in the safety criterion for specular and diffuse reflection is described depending on the characteristics of the reflecting surface placed in the path of the beam. Polar diagrams of four types of reflecting surfaces are examined in terms of their influence on safety level calculations. The effects of atmospheric scattering, attenuation, and temperature are considered, and protective measures are discussed. T.M.

A67-41053
THE CONTROL OF THE HAZARDS FROM LASERS.

D. F. White (United Kingdom Atomic Energy Authority, Radiological Protection Div., Health and Safety Branch, Harwell, Berks., England).
(British Occupational Hygiene Society, Symposium on Protection Against the Dangers of Laser Radiation, London School of Hygiene and Tropical Medicine, London, England, Nov. 7, 1966, Paper.)
Annals of Occupational Hygiene, Supplement, July 1967, p. 55-60.

Survey of the general principles involved in the protection of personnel from hazards associated with the use of lasers. General methods of ensuring such protection are proposed which do not depend upon precise estimates of safe intensity levels. Three methods of hazard control are outlined including: (1) static containment of the laser installation, (2) static screening of the operator, and (3) direct (personal) protection for the eyes. Various types of filters for the eyes are described and their efficiency is evaluated. Methods of applying these control measures are reviewed in relation to the positive cooperation required from the personnel. T.M.

A67-41054
LASERS - PRACTICAL CONTROL AND PROTECTION IN EXPERIMENTAL LABORATORIES.
J. M. Burch and J. W. C. Gates (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England).
(British Occupational Hygiene Society, Symposium on Protection Against the Dangers of Laser Radiation, London School of Hygiene and Tropical Medicine, London, England, Nov. 7, 1966, Paper.) Annals of Occupational Hygiene, Supplement, July 1967, p. 65-72; Discussion, p. 72, 73. 7 refs.

The paper presents an account of the measures which have been taken in a laser research laboratory to deal with the risks which the operation of lasers may entail. In some circumstances, responsibility for ensuring the safety of persons not actually engaged in the work may require precautions which seriously hamper progress; a policy of strictly excluding persons not engaged in the work has been found useful. Some further observations on the probable requirements for safety precautions in the future are made.
(Author)

A67-41152
ENERGETIC PLASMAS PRODUCED BY LASER LIGHT ON SOLID TARGETS.
H. Opower, W. Kaiser, H. Puell, and W. Heinicke (München, Technische Hochschule, Physik-Departement, Munich, West Germany).
Zeitschrift für Naturforschung, Ausgabe A, vol. 22a, Sept. 1967, p. 1392-1397. 20 refs.

Investigation of light intensities of 3×10^{12} watts/cm^2 which were produced in the focus of an LiD target, by means of two parallel simultaneously-operating giant pulse lasers. Ion energies in the expanding plasma stream of 4.5 kev were observed. Investigations of thin LiH targets indicated that the light pulse interacts only with a target layer measuring about 10^{-4} cm in thickness. The magnitude of the ion flux is estimated and compared with experimental observations.
R. B. S.

A67-41153
INVESTIGATION OF THE EMISSION OF A 50-HZ RUBY PULSE LASER [UNTERSUCHUNG DER EMISSION EINES 50-HZ-RUBIN-PULSLASERS].
D. Röss and G. Zeidler (Siemens AG, Zentral-Laboratorium für Nachrichtentechnik, Munich, West Germany).
Zeitschrift für Naturforschung, Ausgabe A, vol. 22a, Sept. 1967, p. 1398-1401. 7 refs. In German.

Investigation of the quasi-continual emission of a 1-in. ruby laser characterized by a 50-Hz pulse-train frequency. An average output of 1 watt for each 1.3-msec pulse is achieved, and the reproducibility of the time behavior is better than 2%. Curves showing the time behavior for both near and far fields are given. The electromagnetic emission spectrum was analyzed with a fast-reacting photodiode and a heterodyne detector in the frequency range between 10 kHz and 1 GHz, and the interaction of the transverse modes leads to the appearance of spectrum lines of some hundred MHz. R. B. S.

A67-41180
DEVELOPMENTAL TESTS OF A WHITE LIGHT STANDARD FOR COLORIMETRY. II [ESSAIS DE REALISATION D'UN ETALON DE LUMIERE BLANCHE POUR LA COLORIMETRIE. II].
Félicien Blottiau, Georges Penciolelli, and Serge Slansky (Institut d'Optique Théorique et Appliquée, Paris, France).
Revue d'Optique, vol. 46, Feb. 1967, p. 83-92. 6 refs. In French.

Theoretical demonstration that the visible light emitted by a blackbody at 2800°K can be changed into an energy distribution close to that of a blackbody at 5500°K by means of a suitably chosen Fabry-Pérot filter. The tristimulus values of white lights developed in linking such a filter to a standard source A are calculated in terms of the distance separating the mirrors of the filter and in terms of their reflection factor assumed to be independent of wavelength. The characteristics of the filters giving the chromaticities of the lights B, C, and E are calculated, as well as the energy distribution of the lights obtained by this method. The accuracy required to satisfy the eye's sensitivity to chromaticity differences is discussed. Consideration is given, in the case of light C, to the modification of the filter characteristics in order to take into account the absorption due to mirrors (assumed to consist of aluminum films) and the spectral changes in both reflectance and transmittance.
F. R. L.

A67-41184
FARADAY ROTATION IN YIG.
R. W. Cooper and R. F. Pearson (Mullard, Ltd., Mullard Research Laboratories, Salfords, Surrey, England).
IN: MAGNETIC MATERIALS AND THEIR APPLICATIONS; CONFERENCE, LONDON, ENGLAND, SEPTEMBER 26-28, 1967, PAPERS. [A67-41181 23-26]
Conference sponsored by the Institution of Electrical Engineers, the Institute of Physics, the Physical Society, and the United Kingdom and Republic of Ireland Section of the Institute of Electrical and Electronics Engineers.
London, Institution of Electrical Engineers (IEE Conference Publication No. 33), 1967, p. 155-158.

Study of the origin of Faraday rotation in yttrium iron garnet (YIG) to permit the design of materials with optimum properties for a particular application. Measurements are made of the Faraday rotation and absorption at the helium-neon laser wavelengths of 1.15 and 3.39 μ on substituted single-crystal YIG composed of $Y_3Fe_{5-x}M_xO_{12}$, where M = In, Sc, Ga, Al and $x = 0 \rightarrow 1.45$. The results for a Faraday rotation of 1.15 μ are plotted.
B. B.

A67-41192
GENERATION OF THE SECOND HARMONIC OF LASER RADIATION IN SELENIUM AND IN A TELLURIUM-SELENIUM ALLOY [GENERATION DU SECOND HARMONIQUE D'UN RAYONNEMENT LASER DANS LE SELENIUM ET DANS UN ALLIAGE TELLURE-SELENIUM].
Jean Jerphagnon, Edmond Batifol, and Marcelle Sourbe (Centre National d'Etudes des Télécommunications, Département Physique, Chimie, Metallurgie, Issy-les-Moulineaux, Hauts-de-Seine, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 265, no. 7, Aug. 16, 1967, p. 400-402. 8 refs. In French.

Use of a CO_2 laser, continuous or Q-switched, as a light source to generate a second harmonic in selenium and in a tellurium-selenium alloy. The nonlinear coefficients and the directions of synchronism at 10.6 μ were measured.
F. R. L.

A67-41193
EMISSION OF GaSb INJECTION LASERS IN A PULSED REGIME [EMISSION DE LASERS A INJECTION AU GaSb EN REGIME D'IMPULSIONS].
Henry Mathieu and Georges Sagnes (Montpellier, Université, Centre d'Etudes d'Electronique des Solides, Montpellier, France).
Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques, vol. 265, no. 7, Aug. 16, 1967, p. 406-409. 7 refs. In French.

Demonstration of the existence of two laser lines with distinct thresholds. They originate from different regions of the diode, and are staggered in time and space. The emission can be explained by the injection of electrons in the p-type region and holes in the n-type region.
F. R. L.

A67-41226
FABRICATION OF WIDE BORE HOLLOW CATHODE Hg^+ LASERS.
H. Wieder, R. A. Myers, C. L. Fisher, C. G. Powell, and J. Colombo (International Business Machines Corp., Thomas J. Watson Research Center, Yorktown Heights, N.Y.).
Review of Scientific Instruments, vol. 38, Oct. 1967, p. 1538-1540. 5 refs.
Contract No. AF 33(615)-3655.

Description of an improved version of a hollow-cathode Hg^+ laser which provides improved performance, stability, and reproducibility over the earlier model described by Byer et al. (1965). This laser tube consists of a hollow cylindrical cathode and a pair of ring anodes sealed into a glass enclosure. While a number of metals have been used with moderate success as electrodes, tantalum appears to provide the steadiest, most trouble-free discharge.
M. F.

A67-41265
ANALYSIS OF A PROGRAMMED MULTIPULSE LASER RANGE MEASUREMENT SYSTEM.
T. S. Morrison (Technical Communications Corp., Lexington, Mass.) and S. Ackerman (EG&G, Inc., Bedford, Mass.).
Applied Optics, vol. 6, Oct. 1967, p. 1725-1727. 6 refs.
USAF-supported research.

The energy detection of multipulse returns from an optically rough target is considered. A Q-switched laser generates a number of precisely timed giant pulses during a single pumping period. The multipulse signal photoelectron statistics are shown to be negative binomial. The statistical detection performance of single and multipulse systems are compared over a wide range of noise levels. The multipulse rangefinder has a power advantage of from 15 to over 28 db under the conditions considered. (Author)

A67-41266
THE EFFECT OF ATMOSPHERIC SCINTILLATION ON AN OPTICAL DATA CHANNEL-LASER RADAR AND BINARY COMMUNICATIONS.
D. L. Fried and R. A. Schmeltzer (North American Aviation, Inc., Autonetics Div., Electro-Optical Laboratory, Anaheim, Calif.).
Applied Optics, vol. 6, Oct. 1967, p. 1729-1737. 11 refs.

The effects of scintillation on an optical data channel are analyzed and numerical results presented. Scintillation with a log normal distribution typical of atmospheric optical effects is assumed. The analysis is concerned with the target miss probability of a laser radar and the bit error probability of an optical binary communications link. Results are expressed in terms of a loss factor which is the extra number of db SNR necessary to keep the performance in the presence of scintillation up to the level achievable in the absence of scintillation. With even moderately weak scintillation, large loss factors are encountered. A brief treatment of the effects of normally distributed scintillation is also presented. (Author)

A67-41270
REACTIVE OPTICAL INFORMATION PROCESSING. II.
H. Wieder and R. V. Pole (International Business Machines Corp., Thomas J. Watson Research Center, Yorktown Heights, N.Y.).
Applied Optics, vol. 6, Oct. 1967, p. 1761-1765. 6 refs.

Examination of the aspects of reactive optical-information processing which affect its successful implementation, based on the fact that information may be efficiently extracted from a phase object when this object is placed within a laser cavity. It is shown that the relief depth of the object is decisive in determining the maximum attainable efficiency and that the absorption losses in the object and the excess gain of the laser play important roles in determining whether this maximum efficiency is realized. The reactive, or intracavity, processing method is shown to be equally applicable to such diverse applications as the investigation of refractive-index perturbations over long path lengths and the retrieval of information from phase-modulated emulsions. The results obtained in processing a representative selection of phase objects are discussed. P.v.T.

A67-41322 #
PROPERTIES OF RUBY RESONATORS WITH PLANE AND SPHERICAL FACES [VLASTNOSTI RUBÍNOVÝCH REZONÁTORŮ S ROVINNÝMI A KULOVÝMI ČELY].
Vl. Boček and M. Liška (Vysoké Učení Technické, Strojní Fakulta, Katedra Fyziky, Brno, Czechoslovakia).
Jemná Mechanika a Optika, vol. 12, Sept. 1967, p. 269-271. In Czech.

Comparison of the beam properties of laser radiation using two different ruby resonators: (1) resonators having large-radius spherical faces, and (2) resonators in the shape of a Fabry-Pérot resonator. The comparison is conducted for the purpose of analyzing the operation of optically concentrated laser beams. The following properties are examined: (1) the dependence of output power on input power, (2) the beam divergence, (3) the radiation density in the concentrated beam, and (4) the near field of the resonator. It is shown that spherical resonators are better suited for lower radiation doses, while plane resonators are more advantageous for applications requiring higher radiation doses. T. M.

A67-41324
EARS ON THE LINE PROFILE OF DECAY TRANSITIONS IN A GAS LASER.
W. G. Schweitzer, Jr., M. M. Birky (National Bureau of Standards, Atomic Physics Div., Washington, D.C.), and J. A. White (National Bureau of Standards; American University, Washington, D.C.).
Optical Society of America, Journal, vol. 57, Oct. 1967, p. 1226-1230. 9 refs.

Observation of a structure contained in a gas-laser spectrum line whose upper state is the lower state of the laser transition. This structure is referred to as ears, on the 6096-Å neon line emitted spontaneously in a 1.15 μ He-Ne laser. The ear width was measured interferometrically and compared with the width predicted from the phenomenological width γ_{ab}/π in the laser transition. P.v.T.

A67-41379
A GALLIUM ARSENIDE (GaAs) LASER DIODE COMMUNICATOR.
F. Terry Harris, Donald P. Lubin (Radio Corporation of America, Defense Electronic Products, Aerospace Systems Div., Burlington, Mass.), and Dainis Karlsons (Radio Corporation of America, Camden, N.J.).
IN: INSTRUMENT SOCIETY OF AMERICA, ANNUAL CONFERENCE, 22ND, CHICAGO, ILL., SEPTEMBER 11-14, 1967, PROCEEDINGS. VOLUME 22. PART II - PHYSICAL AND MECHANICAL MEASUREMENT INSTRUMENTATION. [A67-41367 23-14]
Pittsburgh, Instrument Society of America, 1967. 8 p.

Description of a two-terminal communication system using commercially available GaAs laser room-temperature diodes. Various component-selection techniques for the laser driver and their relation to system performance are discussed. The mechanical and optical construction, and the design improvements and their effects on system performance are considered. It is pointed out that the semiconductor laser diode can be a very useful device for communication, ranging, and tracking. Very compact communicators can be built which are capable of ranges in excess of two miles. The basic receiving and driving circuitry can be applied to GaAs, as well as any new semiconductor material. M.M.

A67-41380
APPLICATIONS OF LASER PHOTOGRAPHY TO HYPERTHERMAL WIND TUNNEL ABLATION TESTING.
J. E. Arnold and H. J. Bomelburg (North American Aviation, Inc., Atomics International Div., Canoga Park, Calif.).
IN: INSTRUMENT SOCIETY OF AMERICA, ANNUAL CONFERENCE, 22ND, CHICAGO, ILL., SEPTEMBER 11-14, 1967, PROCEEDINGS. VOLUME 22. PART II - PHYSICAL AND MECHANICAL MEASUREMENT INSTRUMENTATION. [A67-41367 23-14]
Pittsburgh, Instrument Society of America, 1967. 15 p. 7 refs.
AEC Contract No. AT (11-1)-GEN-8.

Laser macrophotography has been applied to determine the size distribution of particulate debris dispersed from an ablating zirconium alloy specimen. The unique method devised for obtaining instantaneous photographs of the dispersing particles is described. The resulting photography and particle distribution from ablation tests conducted in a hyperthermal wind tunnel are presented. In a second application, a double-pass laser schlieren system was used for the photographic visualization of the effusion of hydrogen prior to the ablation of the test material - namely, uranium-zirconium hydride. The advantages and the difficulties in the operation of such a system are discussed in connection with the results obtained from tests. The application of the system to arcjet ablation testing was beyond the state-of-the-art and required extensive development of testing techniques. (Author)

A67-41393
THE ELECTRON BEAM SCANLASER - THEORETICAL AND OPERATIONAL STUDIES.
R. A. Myers (International Business Machines Corp., Thomas J. Watson Research Center, Yorktown Heights, N.Y.) and R. V. Pole (International Business Machines Corp., Thomas J. Watson Research Center, Optical Physics Research Group, Yorktown Heights, N.Y.).
IBM Journal of Research and Development, vol. 11, Sept. 1967, p. 502-510. 17 refs.
Contract No. AF 33(615)-3655.

The paper presents the theory, design, and initially observed operating parameters of the Electron Beam Scanlaser, a scanning laser device in which a modified electrooptic display tube selects one of many degenerate transverse modes of a flat-field conjugate resonator. The version considered uses a KDP crystal in the mode selector and an ionized mercury hollow cathode discharge as active

element. Some observations reported are resolution (10 lines/mm), sweep rate (100 μsec/line), light decay time (2 msec, minimum), and power/spot (1 watt pulsed). Laser output power is about 30 db greater than electron beam power. (Author)

A67-41433 #

THREE-WAVE OPTICAL-MIXING EFFECTS IN WEDGE-SHAPED CELLS.

Akira Nabara and Kanji Kubota (Osaka University, Dept. of Physics, Osaka, Japan).

Japanese Journal of Applied Physics, vol. 6, Sept. 1967, p. 1105-1108. 7 refs.

The optical-mixing process in which the light at the frequency of $2\omega_1-\omega_2$ is generated from two incident beams at ω_1 and ω_2 through the polarization of the third order in the electric field is studied in several kinds of liquid using a sample cell with nonparallel windows. The dependence of the output light intensity at $2\omega_1-\omega_2$ on the optical thickness z and the angle α of parallelism of the cell is obtained. For small α, the output intensity oscillates as z is changed except C_6H_6, in which a different behavior is observed under the same condition. For large α, this oscillatory behavior is observed fairly small. In these experiments, the optical path length z is 10 to 15 times as long as the coherence length. The third-order nonlinear susceptibilities have been estimated to be of the order of 10^{-12} to 10^{-14} cm^3/erg. (Author)

A67-41434 #

INFLUENCE OF GIANT PULSE IRRADIATION ON A RUBY LASER.

Toshizo Nakaya (Konan University, Dept. of Physics, Kobe, Japan) and Hirobumi Okabe (Osaka Prefecture, Industrial Research Institute, Osaka, Japan).

Japanese Journal of Applied Physics, vol. 6, Sept. 1967, p. 1109-1115. 7 refs.

In an optical system consisting of two ruby lasers (one is Q-switching operation, the other normal operation), the following phenomena have been studied on the basis of the experimental results obtained on the fractional metastable state population: (1) quenching of normal laser oscillation, (2) amplification of incident giant pulse by maser mechanism, and (3) changes in giant pulse characteristics by giant pulse irradiation in a Q-switching laser with saturable absorber. A block diagram of the experimental setup is shown. (Author)

A67-41465

POWER OUTPUT AND EFFICIENCY OF CONTINUOUS RUBY LASERS.

V. Evtuhov and J. K. Neeland (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.).

Journal of Applied Physics, vol. 38, Sept. 1967, p. 4051-4056. 35 refs.
USAF-supported research.

The paper reports recent observations on the performance of continuous ruby lasers and compares them with theoretical computations of threshold, power output, and efficiency. The theoretical model includes effects due to scattering, temperature, ^2E level splitting, and excited-state absorption. It is used to compute numerically the optimized output coupling for various pump levels and the corresponding power outputs. Experimentally, power outputs of up to 2.4 watts, and incremental (above threshold) efficiencies of ~0.11% were observed. Some experiments on the effects of differing crystal diameters and cooling water temperatures and flow rates were performed. Good agreement was obtained between the observed and computed dependence of power output and efficiency on various laser parameters. The agreement is of significance primarily because it implies that the theoretical model can be used in optimizing the design of continuous ruby lasers and in predicting their performance. Results of rough calculations of projected performance are given. (Author)

A67-41470

LASER DAMAGE ON SEMICONDUCTOR SURFACES.

M. Bertolotti, F. de Pasquale, P. Marietti, D. Sette, and G. Vitali (Roma, Università, Istituto di Fisica, Consiglio Nazionale delle Ricerche, Gruppo Nazionale Struttura della Materia, Rome, Italy).

Journal of Applied Physics, vol. 38, Sept. 1967, p. 4088-4090. 15 refs.

Study of the effects of laser irradiation on Ge, Si, GaAs, GaSb, InSb, and CdSe semiconductor crystals, using a normal pulsed ruby laser emitting a train of spikes for about 0.5 msec. At very low energy density the exposed surface after irradiation shows areas which have lost their flatness and appear slightly moved. These areas are distributed inside a total region which has neither a definite symmetry nor sharp boundaries. B.B.

A67-41471

INFRARED ABSORPTION AT 10.6 μ IN GaAs.

J. Comly, E. Garmire, and A. Yariv (California Institute of Technology, Electrical Engineering Dept., Pasadena, Calif.).

Journal of Applied Physics, vol. 38, Sept. 1967, p. 4091, 4092. 5 refs.
USAF-Navy-supported research.

Determination of the fraction of incident light intensity absorbed at 10.6 μ by measuring the residual IR absorption in samples of GaAs with resistivities higher than 10^4 ohm-cm. The value found was 0.006 ± 0.002/cm. This low absorption indicates that high-resistivity GaAs is suitable for modulation of high-power CO_2 laser light. Since it was found that the absorption at 10.6 μ in GaAs was independent of resistivity from 10^4 to 10^9 ohm-cm, it is clear that free-carrier absorption is not important at these low carrier concentrations. M.M.

A67-41681

TRAPPING OF PARTICLES BY WAVES.

V. E. Liamov and L. G. Sapogin (Taganrogskii Radiotekhnicheskii Institut, Taganrog, USSR).

(Zhurnal Tekhnicheskoi Fiziki, vol. 37, Apr. 1967, p. 624-632.)
Soviet Physics - Technical Physics, vol. 12, Oct. 1967, p. 449-454. 9 refs. Translation.

Investigation of the effects of the trapping of both neutral and charged particles by waves. Wave attenuation due to interaction with particles is considered for both elastic and inelastic collisions, and relationships are derived between the trapping and wave attenuation. The current due to the interaction of charged particles with a wave is examined, and it is shown that the trapping emf increases with decreasing phase velocity of the wave. Possible trapping effects in waveguides with plasma and in semiconductors are analyzed. Electron trapping by electromagnetic waves in conducting media is studied, and trapping by a laser beam is examined. The effect due to electron trapping in a hydrogen plasma by a laser beam is shown to be quite substantial and may be used for measurement of large transmitted powers. It is possible to accelerate charged particles in the direction of wave propagation, using a laser beam. T.M.

A67-41765

LASER BEAMS AND INTEGRATED CIRCUITS.

M. I. Cohen (Bell Telephone Laboratories, Mechanics Study Group, Murray Hill, N.J.).

Bell Laboratories Record, vol. 45, Sept. 1967, p. 246-251.

Review of laser applications in the welding and machining of thin-film and semiconductor integrated circuits. The advantages of using laser beams for these applications are surveyed including the welding of small-area connections, drilling holes, and cutting away sections for such purposes as capacitor fabrication. Laser-beam parameters affecting welding and machining are discussed in terms of radiation wavelength, power, pulse duration, the angle of divergence and beam diameter, and the spatial and temporal variations of the laser output. Problems involved with an efficient beam application to the processed surface are examined and currently used techniques for welding and drilling are outlined. A 10-pf gap capacitor cut with the use of the neodymium-doped yttrium aluminum garnet (YAG) continuous laser is described. T.M.

A67-41771

POLARIZATION OF THE RADIATION FROM A RUBY LASER.

A. I. Alekseev and Iu. P. Nikitin (Moskovskii Inzhenerno-Fizicheskii Institut, Moscow, USSR).

(Fizika Tverdogo Tela, vol. 9, May 1967, p. 1309-1315.)
Soviet Physics - Solid State, vol. 9, Nov. 1967, p. 1024-1029. 10 refs. Translation.

[For abstract see issue 15, page 2499, Accession no. A67-29701]

A67-41774
ABSORPTION OF LASER RADIATION AND DAMAGE IN SEMICONDUCTORS.
A. A. Grinberg, R. F. Mekhtiev, S. M. Ryvkin, V. M. Salmanov, and I. D. Iaroshetskii (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR; Akademiia Nauk Azerbaidzhanskoi SSR, Institut Fiziki, Baku, Azerbaidzhan SSR).
(Fizika Tverdogo Tela, vol. 9, May 1967, p. 1390-1397.)
Soviet Physics - Solid State, vol. 9, Nov. 1967, p. 1085-1090. Translation.
[For abstract see issue 15, page 2537, Accession no. A67-29704]

A67-41799 #
SEALED-OFF HIGH-POWER CO_2 LASERS.
W. J. Witteman (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands).
Philips Technical Review, vol. 28, no. 10, 1967, p. 287-296. 15 refs.
Description of high-efficiency IR lasers which can be produced by using the vibrational-rotational transitions of CO_2. Described types of experimental sealed-off CO_2 lasers are: (1) with variable coupling-out using a germanium mirror outside the laser tube; (2) using a plane-parallel germanium plate as an exit window perpendicular to the tube axis and a single concave mirror; and (3) using two concave mirrors - the one for coupling-out being of zinc selenide. B.B.

A67-41861 * #
ABSOLUTE FREQUENCY MEASUREMENTS ON NEW CW HCN SUBMILLIMETER LASER LINES.
L. O. Hocker and A. Javan (Massachusetts Institute of Technology, Dept. of Physics, Cambridge, Mass.).
Physics Letters, vol. 25A, Oct. 9, 1967, p. 489, 490.
NASA-USAF-supported research.
Description of new CW laser lines at 373, 335, 310, and 284 μ, which have been made to oscillate as pure rotational cascade transitions pumped by the 337- and 311-μ HCN lines. Frequency measurement of three of these new lines confirms this identification. M.M.

A67-41863 #
SATURABLE TRANSMISSION BY MULTIPHOTON ABSORPTION IN SEMICONDUCTORS.
R. Braunstein (California, University, Dept. of Physics, Los Angeles, Calif.).
Physics Letters, vol. 25A, Oct. 9, 1967, p. 535, 536. 17 refs.
Contract No. Nonr-233(93).
Discussion of recent measurements of double-photon absorption in a number of semiconductors, and their bearing on the theory developed for the two-photon excitation of interband transitions. It is noted that multiphoton absorption can set an intrinsic upper limit to the power density that can be transmitted through semiconductors. This mechanism is an effective means of optically pumping semiconductor lasers and can limit the power density from such devices, or can enable the fashioning of nonlinear optical power limiters. M.M.

A67-41883
OBSERVATION OF RAMAN SCATTERING FROM THE ATMOSPHERE USING A PULSED NITROGEN ULTRAVIOLET LASER.
Donald A. Leonard (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
Nature, vol. 216, Oct. 14, 1967, p. 142, 143. 6 refs.
Experimental observation of optical Raman scattering from oxygen and nitrogen in the atmosphere, using a pulsed nitrogen UV laser as a light source. A spectral analysis of the experimentally obtained air scattering return at zero elevation is shown, and the magnitude of the observed Raman signals is found to be consistent with the expected signal calculated on the basis of an estimated Raman cross section of 10^{-29} cm^2. Typical oscillograms of the photomultiplier signal obtained at the 3658 Å nitrogen Raman line are also given. R. B. S.

A67-41887
POPULATION AND CURRENT NOISE IN SEMICONDUCTOR LASER JUNCTIONS.
H. Haug (Stuttgart, Technische Hochschule, Institut für theoretische Physik, Stuttgart, West Germany).
Zeitschrift für Physik, vol. 206, no. 2, 1967, p. 163-176. 12 refs.
Research supported by the Deutsche Forschungsgemeinschaft.
Calculation of the population noise in a semiconductor laser by means of the quantum mechanical Langevin method. The manner in which the current dependence of the noise spectrum changes in the shot-noise region if the current passes the threshold of laser action is investigated. Quantum-mechanical equations of motion for the electrons and for the coupled laser mode are given, and damping terms and fluctuations are treated according to the quantum-mechanical Langevin method. The resulting coupled equations for the electron population and the light field are applied in the regions above and below the threshold. Finally, the connection between the population and the current noise is determined. R.B.S.

A67-41903
CONTRIBUTION TO THE PHOTON STATISTICS OF LASER RADIATION [ZUR PHOTONSTATISTIK DER LASERSTRAHLUNG].
Horst D. Clausen (U.S. Army, Research Office, Durham; North Carolina, University, Chapel Hill, N.C.).
Acta Physica Austriaca, vol. 25, no. 3, 1967, p. 266-278. 10 refs.
In German.
Derivation of coherent states by means of a simple field-theoretic model. With the aid of a density matrix for thermal equilibrium, a laser-radiation model consisting of superimposed coherent and incoherent thermal radiations is constructed, and the statistics of the photons are determined. The Bose-Einstein and Poisson distributions are included as special cases. P.V.T.

A67-41908
DIRECT OBSERVATION OF OUTPUT BEAM PATTERNS FROM N_2-CO_2 LASER AT 10.6 μM BY THERMAL DEVELOPMENT METHOD.
H. Inaba, T. Kobayashi, K. Yamawaki, and A. Sugiyama (Tohoku University, Research Institute of Electrical Communication, Sendai, Japan).
(Institute of Electrical Communication Engineers of Japan, Annual Convention, Tokyo, Japan, Nov. 20, 1966, Paper.)
Infrared Physics, vol. 7, Sept. 1967, p. 145-149. 11 refs.
Research supported by the Mainichi Research Grants.
A thermal development method is presented for observing and recording directly the output pattern of laser oscillations at 10.6 μ from N_2-CO_2 systems. This method utilizes the commercially available Kalver film in which the development is produced by the IR laser beam, following uniform exposure to the near UV light around 0.4 μ. It was proved experimentally that the Kalver image obtained with this procedure gives favorable results with continuous tone characteristics as compared with the evaporographic method for detecting the IR radiation from relatively low temperature sources. Some typical examples of the direct oscillation pattern from the N_2-CO_2 laser system, using the external resonator configuration and having a central hole in one of the mirrors for the output power coupling, are shown. The effect of the window employed for the discharge tube on the performance of laser operation is also discussed. (Author)

A67-41983 #
INDUCED EMISSION OF $NaCaCeF_6$:Nd^{3+} AT ROOM TEMPERATURE.
A. A. Kaminskii, Ia. E. Lapsker, and B. P. Sobolev (Akademiia Nauk SSSR, Institut Kristallografii, Moscow, USSR).
Physica Status Solidi, vol. 23, no. 1, 1967, p. K5-K7. 6 refs.
Description of improved optical parameters for fluoride materials for use in lasers. $Na_xCa_{3-2x}Ce_xF_6$ crystals grown by the Stockbarger method in a dosed HF atmosphere are used. The absorption spectrum of $Na_xCa_{3-2x}Ce_xF_6$:Nd^{3+} crystals at 300°K, as recorded by an EPS-2U spectrophotometer, are plotted. The absorption coefficient shows some of the characteristic lines. B.B.

A67-42070 #
EFFECT OF THE OPTICAL INHOMOGENEITIES OF AN ACTIVE SUBSTANCE ON THE RADIATION-FIELD STRUCTURE OF A RUBY LASER [PRO VPLIV OPTICHNIKH NEODNORIDNOSTEI AKTIVNOI RECHOVINI NA STRUKTURU POLIA VIPROMINIUVANNIA OPTICHNOGO KVANTOVOGO GENERATORA NA RUBINI].
A. V. Soloviov, E. O. Tikhonov, and M. T. Shpak (Akademiia Nauk Ukrains'koi RSR, Institut Fiziki, Kiev, Ukrainian SSR).
Ukrains'kii Fizichnii Zhurnal, vol. 12, Sept. 1967, p. 1430-1434. 15 refs. In Ukrainian.

Experimental proof of a relation between the radiation-field structure of a ruby laser and structural inhomogeneities of its crystal, based on a study of the performance of a group of 10 ruby rods 120 to 240 mm long, prepared by the Verneuil method and inverted in a plane-parallel resonator. The marked asymmetry of the radiation field and the highly anomalous angle of divergence of the laser beam observed in the experiments are linked to structural dislocations common in ruby crystals prepared by this method. V. Z.

A67-42074 #
GENERATION OF THE SECOND OPTICAL HARMONIC IN GaSe CRYSTALS [GENERATSIIA DRUGOI OPTICHNOI GARMONIKI VIPROMINIUVANNIA KRISTALIV GaSe].
M. S. Brodin and M. V. Volovik (Akademiia Nauk Ukrains'koi RSR, Institut Fiziki, Kiev, Ukrainian SSR).
Ukrains'kii Fizichnii Zhurnal, vol. 12, Sept. 1967, p. 1501-1506. 13 refs. In Ukrainian.

Observation of the emission of the second optical harmonic in GaSe semiconductors exposed to steady or pulsed ruby laser radiation. The intensity of this harmonic is proportional to the square of the intensity of the laser pulse and remains unchanged in GaSe samples down to 7μ thick, an observation suggesting that only the surface layer is active in the generation of this harmonic. V. Z.

A67-42091 #
SPATIAL COHERENCE AND MODE STRUCTURE IN THE He-Ne LASER.
D. C. W. Morley, D. G. Schofield, L. Allen, and D. G. C. Jones (Sussex, University, School of Mathematical and Physical Sciences, Brighton, England).
British Journal of Applied Physics, vol. 18, Oct. 1967, p. 1419-1422. 5 refs.
Research supported by the Science Research Council.

Derivation of a formula which makes it possible to calculate the degree of coherence across the beam of a multimode laser. Good experimental agreement is obtained for the case TEM_{00} and TEM_{10} modes in simultaneous oscillation. M.M.

A67-42098 #
MULTI-PHOTON ABSORPTION IN MONATOMIC GASES.
V. M. Morton (Central Electricity Generating Board, Research Laboratories, Leatherhead, Surrey, England).
Physical Society, Proceedings, vol. 92, Oct. 1967, p. 301-310. 32 refs.

A theoretical discussion of the ionization of an atom by the simultaneous absorption of many photons is presented. This process may be relevant to the production of plasmas by concentrated beams of intense radiation from lasers. Approximate methods are developed for evaluating the quantum-mechanical expression for the ionization probability. It is shown that the r·E form of the interaction Hamiltonian is greatly preferable to the p·A form. Comparison of the numerical results with experiment shows that at moderate pressures this process can at best only provide the initiating electron, and the growth of the plasma must then take place by other means - e.g., inverse bremsstrahlung. Even to sustain this argument it is necessary to assume that the radiation is normally incoherent, and the role of inhomogeneities in increasing the overall ionization probability is stressed. At low pressures, where the second process is inhibited, better agreement is found. Finally, the enhancement of the ionization probability which occurs when a natural atomic level lies close to an integral number of photon energies above the ground state is illustrated by a specific example (lithium). A fourfold drop in the threshold flux for ionization is predicted when a ruby laser is tuned through such a resonance. (Author)

A67-42164 #
ELECTRIFICATION OF CRYSTALS OF SEMICONDUCTOR COMPOUNDS OF $A^{II}B^{VI}$ AND $A^{III}B^{V}$ TYPE AFTER EXPOSURE TO LIGHT PULSES FROM A LASER [ELEKTRIZATSIIA KRISTALLOV POLUPROVODNIKOVYKH SOEDINENII TIPA $A^{II}B^{VI}$ I $A^{III}B^{V}$ POSLE VOZDEISTVIIA IMPUL'SOV SVETA OT OPTICHESKOGO KVANTOVOGO GENERATORA].
B. A. Krasiuk and T. S. Stepanova.
Akademiia Nauk SSSR, Doklady, vol. 176, Sept. 11, 1967, p. 365-367. In Russian.

Discussion of experiments in which plane-parallel CdSe, CdTe, InP, GaP, AlSb, InSb, and GaSb single crystals varying in thickness from 1 to 2 mm (area of ~0.5 mm^2), thoroughly cleaned and brightly polished, were exposed to ruby-laser pulses with energies from 0.1 to 0.7 joule and a duration of 3.5 msec. It is found that the magnitude of the charge appearing on the samples as a result of this exposure varies for these crystals in the same order as their ionic bonds - namely: CdSe → CdTe → InP → GaP → AlSb → InSb → GaSb. V.P.

A67-42174 #
AN ACCURATE CARBON CONE CALORIMETER FOR PULSED LASERS.
J. G. Edwards (Ministry of Technology, National Physical Laboratory, Div. of Optical Meteorology, Teddington, Middx., England).
Journal of Scientific Instruments, vol. 44, Oct. 1967, p. 835-838. 5 refs.

The requirements for a laser calorimeter are discussed with reference to a particular thick-walled carbon cone equipped with eight thermocouples and a resistance wire to discharge a known energy for calibration purposes. The main sources of error are (1) incomplete absorption of the laser beam, (2) the cooling error due to the finite time for redistribution of the heat along the cone, and (3) the measurement of the calibrating energy. An accuracy to better than 4% can be obtained, however, provided certain conditions are fulfilled. Although simple to construct, the calorimeter is not very convenient to use and should be regarded as a means of calibrating another detector. (Author)

A67-42207 #
A PROBLEM OF LASER PULSE DELAY IN He-Ne MIXTURE AT PULSE EXCITATION.
W. Woliński (Warszawa, Politechnika, Katedra Przyrządów Elektronowych, Warsaw, Poland).
(Conference on the Radiospectroscopy and Quantum Electronics, Poznań, Poland, Apr. 1966, Paper.)
Académie Polonaise des Sciences, Bulletin, Série des Sciences Techniques, vol. 15, no. 7, 1967, p. 85-94. 7 refs.

Measurement of the delay of a He-Ne laser pulse with respect to the exciting pulse for various total gas pressures and various neon partial pressures. Curves are given for the dependence of the delay duration on the total gas pressure for various helium and neon pressure ratios, and it is demonstrated that the delay duration depends only on the neon partial pressure at a constant level of the optical-resonator losses. It is also shown that the width of the exciting pulse directly influences the effective concentration of the excited helium atoms and indirectly influences the delay duration. It is concluded that for constant parameters of the optical resonator, the delay time of the laser pulse decreases with an increase in the neon partial pressure and a narrowing of the exciting pulse. T. M.

A67-42238
RUBY MASER OPERATING IN THE 8 mm RANGE.
V. I. Zagatin, G. S. Misezhnikov, and V. B. Shteinshleiger.
(Radiotekhnika i Elektronika, vol. 12, Mar. 1967, p. 539, 540.)
Radio Engineering and Electronic Physics, vol. 12, Mar. 1967, p. 501, 502. Translation.

Discussion of the advantages of using ruby as the active material for an 8-mm traveling-wave maser (TWM). The advantages of using ruby over other paramagnetic materials such as rutile and zinc tungstate are listed. Results of experiments show that the use of ruby as the active material for an 8-mm TWM made it possible to obtain the desired parameter for a traveling-wave amplifier at $T = 4.2^{\circ}K$ - i.e., without pumping helium vapor. M.F.

A67-42239
THE USE OF 45° X-CUT ADP CRYSTALS IN LASER EMISSION CONTROL DEVICES.
I. V. Pirshin and M. M. Koblova.
(Radiotekhnika i Elektronika, vol. 12, Mar. 1967, p. 540-542.) Radio Engineering and Electronic Physics, vol. 12, Mar. 1967, p. 503-505. 8 refs. Translation.

Discussion of the use of a 45° X- (or Y-) cut ADP crystal in devices for controlling laser emission. Tests were made of 45° X-cut ADP in a beam-deflection device and in a Michelson interferometer modulator. For the modulator tests, ADP crystals with the dimensions 0.4 x 0.3 x 5 cm were used. The voltage amplitude necessary for 100% modulation was found to be 100 v, compared to a calculated value of 90 v. M.F.

A67-42360
LASER POWER STABILIZATION BY MEANS OF NONLINEAR ABSORPTION.
R. H. Pantell and J. Warszawski (Stanford University, Stanford, Calif.).
Applied Physics Letters, vol. 11, Oct. 1, 1967, p. 213-215.
NSF-sponsored research.

Observation that, if a medium with an absorption constant which increases with light intensity is placed within a laser interferometer, then fluctuations in the power output of the laser can be decreased. In this manner the typical spiking behavior of a pulsed, solid-state laser can be essentially reduced to a constant output power as a function of time. A material with the desired property is one that is Rayleigh-active, for once threshold is reached for the stimulated Rayleigh effect the absorption at the pump frequency increases with intensity. The threshold for the stimulated Rayleigh effect is low, because most of the gain is provided by the laser medium. Spike suppression has been achieved for a pulsed ruby laser by placing a cell containing benzene within the laser interferometer. M.F.

A67-42361
TWO-PHOTON ABSORPTION IN ALKALI HALIDES WITH A PULSED N_2 LASER.
M. Geller, D. E. Altman, and T. A. DeTemple (U.S. Naval Material Command, Naval Electronics Laboratory, Center for Command Control and Communications, San Diego, Calif.).
Applied Physics Letters, vol. 11, Oct. 1, 1967, p. 221, 222.
16 refs.

Two-photon absorption has been observed in alkali halide crystals with a 1 Mw superradiant pulse at 3371 Å from a nitrogen gas laser. This multiple quantum process is equivalent to a single-photon absorption in the fundamental absorption edge of the alkali halide with the formation of an exciton and its subsequent trapping at an imperfection to form an F center. The crystals were visibly colored in the regions of high laser flux density. These colored regions, similar to color centers produced by UV radiation in the exciton region, were bleached by radiation in the F center absorption band. (Author)

A67-42364
OPTICAL SECOND-HARMONIC GENERATION PRODUCED BY INTERACTION OF LASER BEAMS AND DRIFTING CARRIERS IN InAs.
J. H. McFee (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
Applied Physics Letters, vol. 11, Oct. 1, 1967, p. 228-230. 6 refs.

Observation of the generation of second-harmonic power associated with the simultaneous application of dc fields and CO_2 laser beams to the narrow band-gap semiconductors InAs and InSb. The nonlinear mechanism responsible for the dc-induced second harmonic is shown to be a mobile-carrier effect and is ascribed to the nonparabolicity of the conduction bands. The experiments clearly demonstrated that the mobile-carrier nonlinearity can be controlled directly by application of external fields. This feature suggests the possibility of utilizing this effect for the modulation of optical beams. M.F.

A67-42368
OPTICAL PULSE COMPRESSION USING BRAGG SCATTERING BY ULTRASONIC WAVES.
M. B. Schulz, M. G. Holland, and L. Davis, Jr. (Raytheon Co., Research Div., Waltham, Mass.).
Applied Physics Letters, vol. 11, Oct. 1, 1967, p. 237-240. 12 refs.

Pulse compression using Bragg scattering of light by an acoustic beam has been demonstrated. An ultrasonic delay line containing a frequency ramp signal is used to scatter monochromatic diverging light. If the incident and divergence angles are properly adjusted, the scattered light is focused and rapidly traverses a slit in front of a photodetector. A 1.16-GHz, 2-μsec pulse has been compressed to 18 nsec. Compressed pulses of 5 nsec should be possible with this scheme. (Author)

A67-42370
EFFECTS OF INTERNAL INDUCED ABSORPTION ON LASER EMISSION.
J. Schwartz, C. S. Naiman (MITHRAS, Inc., Cambridge, Mass.), and R. K. Chang.
Applied Physics Letters, vol. 11, Oct. 1, 1967, p. 242-244. 10 refs.

Nonlinear materials having induced absorption within a laser yield effects that contrast with bleachable absorbers. Prolonged giant pulses with greater spatial homogeneity have been observed. Mechanisms for induced absorption are suggested, with a simple model of nonlinear effects on laser emission. (Author)

A67-42412
ATMOSPHERIC ABSORPTION AND LASER RADIATION.
R. K. Long (Ohio State University, Dept. of Electrical Engineering, Electroscience Laboratory, Columbus, Ohio).
Research supported by the Systems Command of the U.S. Air Force. Columbus, Ohio State University (Engineering Experiment Station Bulletin 199), 1967. 140 p.
$3.50.

The purpose of this paper is to discuss the monochromatic absorption properties of the atmosphere at the oscillation frequencies of a variety of lasers and to compare the results with those obtained by conventional spectrographic techniques. The absorption coefficient at wavelengths corresponding to existing lasers is examined, and the wavelengths (windows) for which molecular resonance absorption is small are determined. Possible experiments aimed at measuring the concentration of CH_4, N_2O, and O_3 at high altitudes are described, together with an experiment on the modulation of a laser as a means of obtaining an extremely high-resolution measurement of the profile (as a function of pressure) of an IR absorption line in order to compare it with existing theories of spectral line broadening. This experiment depends on finding a laser frequency separated from an absorption-line center by a frequency increment in the microwave range, so that modulation may be employed. An absorption-cell apparatus designed for absorption measurements is described, together with the measurement of water-vapor absorption at 11,522.76 Å, using a helium-neon laser. Absorption for the ruby-laser wavelength is examined, showing that such a laser can be tuned over a 10-Å range by varying the crystal temperature from 88 to 300°K. The possibility of devising a laboratory method for measuring extinction coefficients lower than 10^{-7} per cm on the basis of the Q value of an optical cavity with and without gas is considered. V.P.

A67-42561 #
THE INFLUENCE OF PLASMA INSTABILITY ON THE OPERATION OF GAS LASERS [VLIV NESTABILITY PLAZMATU NA ČINNOST PLYNOVÝCH LASERŮ].
M. Šícha, V. Veselý (Karlova Universita, Katedra Elektroniky a Vakuové Fyziky, Prague, Czechoslovakia), and M. Kutík (TESLA, Výzkumný Ústav Vakuové Elektroniky, Prague, Czechoslovakia).
Slaboproudý Obzor, vol. 28, Oct. 1967, p. 637-641. 14 refs.
In Czech.

Examination of the discharge instability in gas lasers and its influence on laser operation. It is shown that for certain discharge parameters reactive oscillations take place at currents lower than

the recommended operating regime. The discharge in a prototype ENL 1 laser at current levels higher than those for the reactive oscillations is stable and does not exhibit any tendency toward self-excitation of the moving layers. In the gas-discharge ENV 3 laser self-excitation of the moving layers occurred at current levels above those required for the reactive oscillations, and it is shown that the amplitude of the laser-beam modulation (due to the moving layers) is below the noise level. It is further demonstrated that beam modulation caused by the reactive oscillations is much higher than that caused by the moving layers. The modulation levels of the laser beam and of the light generated by the discharge are equal in this case. T.M.

A67-42574

REACTION OF AN OPTICAL RESONATOR ON A LASER [RÜCKWIRKUNG EINES OPTISCHEN RESONATORS AUF EINEN LASER].
H. Eichler and G. Herziger (Berlin, Technische Universität, I. Physikalisches Institut, Berlin, West Germany).
Zeitschrift für angewandte Physik, vol. 22, no. 5, 1967, p. 297-301. 15 refs. In German.

Theoretical and experimental analysis of the reaction of an optical resonator, coupled to a laser, on the frequency and intensity of the laser light. Different types of reaction occur if the laser and the resonator are coupled strongly or loosely. With strong coupling, hysteresis effects occur. With loose coupling, the reaction could be made so small that it could be disregarded in all applications. P.v.T.

A67-42594

GREEN'S FUNCTION FOR COUPLED OPTICAL MODES.
Roscoe C. Williams (British Columbia, University, Dept. of Physics, Vancouver, Canada).
Annals of Physics, vol. 44, Oct. 2, 1967, p. 479-494. 12 refs.

Determination of the correlation functions for the photons of a laser emitting into two coupled modes by using thermodynamic Green's functions. The coupling is such that an electron which emits a photon into one mode can influence another electron emitting into another mode, so that the photons are therefore cross-correlated. The coupled differential equations for the time-dependent amplitudes of the oscillators (photons) are solved, using thermodynamic Green's functions which contain the stimulation parameters. These parameters are proportional to the absolute square of the matrix element for the stimulated transition. It is found that the cross-stimulation parameter is added to the stimulation parameter of both modes in the expression for the amplitudes of the modes and subtracted from the stimulated parameters in the expressions for the line widths. This has the effect of increasing the amplitudes and the line widths of both modes. The increases are not generally equal, because the stimulation parameters of both modes are not equal. T.M.

A67-42725 #

DISSOCIATION OF CERTAIN $A^{III}B^{V}$ SEMICONDUCTOR COMPOUNDS CAUSED BY THE ACTION OF LIGHT PULSES FROM A LASER [DISSOTSIATSIIA NEKOTORYKH POLUPROVODNIKOVYKH SOEDINENII TIPA $A^{III}B^{V}$, VYZVANNAIA DEISTVIEM IMPUL'SOV SVETA OT OPTICHESKOGO KVANTOVOGO GENERATORA].
B. A. Krasiuk, V. N. Maslov, and T. S. Stepanova.
Akademiia Nauk SSSR, Doklady, vol. 175, Aug. 21, 1967, p. 1320, 1321. In Russian.

Experimental investigation showing that laser pulses with an intensity of less than 1 joule and a duration of 3 to 4 msec are sufficient to produce a local dissociation process in GaAs, GaP, $GaAs_xP_{1-x}$, InAs, and InP. There forms on the surface of the crystal a cavity covered by a gallium (or indium) film which crystallizes in dendritic form. For GaP crystals, the value of the microhardness was found to be equal to 750 kgf/mm^2 for the initial crystal and 14 kgf/mm^2 inside the cavity. V. P.

A67-42813

CZOCHRALSKI-GROWN RUBY AS A MASER MATERIAL.
G. H. J. Schollmeier and D. Roth (Siemens AG, Zentrallaboratorien, Munich, West Germany).
IEEE, Proceedings, vol. 55, Oct. 1967, p. 1745, 1746.

Observation that, in comparison with the standard Verneuil ruby, the Czochralski ruby shows a rather high inversion ratio when used as a microwave maser material in the 4-GHz range. This is in good agreement with the more strictly spin-lattice relaxation behavior observed when testing this material. P. v. T.

A67-42819

LOCAL REFERENCE BEAM GENERATION IN HOLOGRAPHY.
H. J. Caulfield, J. L. Harris, H. W. Hemstreet, Jr., and J. G. Cobb (Texas Instruments, Inc., Dallas, Tex.).
IEEE, Proceedings, vol. 55, Oct. 1967, p. 1758.

Description of a method for constructing laser holograms wherein the only light used is that received directly from the object. Using this method, it is possible to achieve path matching in cases where the distance to the object is unknown. In this method the light need not bypass the object, and beam splitting occurs near the recording medium. One part of the incoming beam (from the object) is made to serve as a reference beam for the other part. This new principle (termed the local reference beam principle) is seen to be well suited for long-distance holography. V.P.

A67-42822

INJECTION LASER HALF ADDER.
Akira Kawaji, H. Yonezu, and T. Nemoto (Nippon Electric Co., Ltd., Central Research Laboratories, Kawasaki, Japan).
IEEE, Proceedings, vol. 55, Oct. 1967, p. 1766, 1767. 6 refs.

Discussion of the mechanism of operation (at 77°K) of a functional device with the logic operation of a half-adder using optical coupling in a single unit of an injection laser. The injection-laser half-adder is designed from the relation among the cavity length, threshold current density, and laser wavelength. Its propagation delay is the time required for the transition of the lasing modes. V.P.

A67-42891

STUDY OF THE DIVERGENCE OF THE RADIATION OF HELIUM-NEON LASERS.
F. A. Abramskii, L. Ia. Gustyr, and V. V. Dontsova.
(Optika i Spektroskopiia, vol. 22, June 1967, p. 962, 963.)
Optics and Spectroscopy, vol. 22, June 1967, p. 520, 521. Translation.

Measurement of the divergence angles of certain types of helium-neon lasers. Optimal conditions for divergence measurements were established. The theoretical results show that in the case of a resonator consisting of two spherical mirrors with unequal radii of curvature, the divergence angle increases sharply when the distance between the mirrors is equal to the radius of curvature of the first or second mirror. The experimental data are in agreement with theory. M.F.

A67-42892

EFFICIENCY OF THE OPTICAL SYSTEM OF A SOLID-STATE LASER WITH CATHODE LUMINESCENT PUMPING.
Iu. G. Anikiev and B. D. Zolotov.
(Optika i Spektroskopiia, vol. 22, June 1967, p. 964-970.)
Optics and Spectroscopy, vol. 22, June 1967, p. 522-525. 7 refs. Translation.

The efficiency of the optical system of a solid-state laser with cathode luminescence pumping is determined analytically. The calculation is carried out for the case when the working crystal and the cathode luminescent screen, the emission of which obeys Lambert's law, constitute a system of coaxial cylinders of length ℓ and L and radii r and R, respectively. The efficiency is determined by introducing coefficients k, σ, $\varkappa$, and ρ_i, which characterize the optical system, and whose values are calculated as functions of r, R, ℓ, and L. The explicit dependence of the optical-system efficiency on these coefficients and on the reflection coefficient of the screen is determined, and numerical values of the efficiency are given in the form of plots for the most important cases. The results can also be used to determine the efficiency of optical systems of other lasers, for example those using coaxial (cavity) tubes and the θ-pinch effect for pumping, and also in the solution of certain problems in cylindrical optics. (Author)

A67-42894
PRODUCTION OF ONE LONGITUDINAL MODE IN A RUBY LASER.
E. I. Nikonova, E. N. Pavlovskaia, and G. P. Startsev.
(Optika i Spektroskopiia, vol. 22, June 1967, p. 984-986.)
Optics and Spectroscopy, vol. 22, June 1967, p. 535-536. 5 refs.
Translation.

Discussion of a method for producing a single longitudinal mode in the emission of a ruby laser operating in the single-pulse regime with a resonant reflector serving as a longitudinal-mode selector. It is pointed out that, to obtain one longitudinal mode in the emission of the ruby laser, it is best to use the single-pulse regime with a resonant reflector as one of the resonator mirrors. This ensures reproducibility of the emission energy within 2 to 3% at a constant pump energy. M.F.

A67-43050 #
TECHNIQUES FOR PLANNING R&D FOR DEEP SPACE COMMUNICATIONS.
Ross E. Graves (Hughes Aircraft Co., Aerospace Group, Culver City, Calif.).
American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 4th, Anaheim, Calif., Oct. 23-27, 1967, Paper 67-973. 10 p. 8 refs.
Members, $1.00; nonmembers, $1.50.

Description of a program designed to develop a methodology for identifying and planning R&D activities for deep-space communications. This methodology comprises a combination of mission and requirements analyses, assessment of the present and projected state-of-the-art in relevant technologies, analytical models for evaluating communications systems and parameters against a number of burden criteria, computer programs for the analytical models, and an executive control program that will allow NASA planners to keep pace with a changing situation. Tradeoff and optimization curves are presented which illustrate the kind of results obtainable, and some preliminary R&D requirements are indicated. R.B.S.

A67-43062
POSSIBLE MASER EFFECT IN CLOUDS OF INTERSTELLAR HYDROGEN IN THE GALACTIC CORONA.
I. S. Shklovskii (Moskovskii Gosudarstvennyi Universitet, Astronomicheskii Institut, Moscow, USSR).
(Astronomicheskii Zhurnal, vol. 44, no. 2, 1967, p. 304-308.)
Soviet Astronomy, vol. 11, Sept.-Oct. 1967, p. 240-243. 5 refs.
Translation.
[For abstract see issue 15, page 2551, Accession no. A67-29139]

A67-43102 #
ION-ENERGY SPECTRUM OF A LASER-CREATED ALUMINA PLASMA [SPECTRE D'ENERGIE DES IONS D'UN PLASMA D'ALUMINE CREE PAR LASER].
P. Briand, T. Consoli, L. Slama, and P. Grelot (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Département de Physique du Plasma et de la Fusion Controlée, Service d'Ionique Générale, Gif-sur-Yvette, Seine-et-Oise, France).
Physics Letters, vol. 25A, Oct. 23, 1967, p. 631, 632. In French.

Description of an experiment to investigate the ion-energy characteristics of an alumina plasmoid obtained by focusing a neodymium laser beam on a solid target. The plasma characteristics produced are measured with a pentagrid energy analyzer. P.v.T.

A67-43103 #
POWER BROADENING AND COLLISION BROADENING OF GAS LASER TRANSITIONS.
P. T. Bolwijn and C. Th. J. Alkemade (Utrecht, Rijksuniversiteit, Fysisch Laboratorium, Utrecht, Netherlands).
Physics Letters, vol. 25A, Oct. 23, 1967, p. 632-634. 14 refs.

Measurement of the tuning characteristics of the amplitude of laser-power modulation in single-mode operation. Power broadening and collision broadening of the laser transition are shown to be relatively important and can be studied separately. The dc laser power is found to be proportional to the square of the gain. B.B.

A67-43104 #
PLASMA IRRADIATED IN A MAGNETIC FIELD.
A. Cavaliere, P. Giupponi, and R. Gratton (EURATOM and Comitato Nazionale per l'Energia Nucleare, Laboratorio Gas Ionizzati, Frascati, Italy).
Physics Letters, vol. 25A, Oct. 23, 1967, p. 636, 637. 5 refs.

Preliminary theoretical study of a laser-irradiated plasma which indicates that the absorption can be significantly enhanced in an external magnetic field. Anticipated self-regulation is realized, resulting in an effective absorption of radiation pulses of several tens of nanoseconds, at striking variance with the free case. B.B.

A67-43105 #
RESONATOR MODES OF SUBMILLIMETERWAVE LASERS.
F. K. Kneubuhl and H. Steffen (Eidgenössische Technische Hochschule, Laboratorium für Festkörperphysik, Zurich, Switzerland).
Physics Letters, vol. 25A, Oct. 23, 1967, p. 639, 640. 10 refs.
Eidgenössische Kommission zur Förderung der Forschung Contract No. 7713.7/639.

Calculation and experimental confirmation of the resonance lengths of the $TEM_{q+1, m, n-1}$ modes occurring in submillimeter-wave laser resonators with concave mirrors, using laser-resonator interferometry. A laser-resonator interferogram of a $BrCn+H_2$ emission into a plane-concave resonator is given. B.B.

Aerospace Medicine and Biology Abstracts

A67-80668
LASER ACTION AT THE CELLULAR LEVEL.
Leon Goldman and R. James Rockwell (Cincinnati U., Med. Center, Laser Lab., Ohio).
(Am. Med. Assn., 115th Ann. Conv., Chicago, Jun. 28, 1966). Journal of the American Medical Association, vol. 198, Nov. 7, 1966, p. 641–644. 16 refs.
Grant PHS OH-00118 and Children's Hosp. Res. Found. and John A. Hartford Found. supported research.

Laser reactions on living tissues when directly applied are presented in detail. These include electric burns, the elastic stress (ultrasonic wave), and the production of free radicals. Techniques for detecting free radicals and processes are discussed. Types of biological specimens are described. The effect of laser reactions on cell structures and the possible uses in therapy are noted. The application of laser microholography in medicine is discussed.

A67-80669
THE SATURATION EFFECT IN RETINA MEASURED BY MEANS OF HE–NE LASER.
J. Blabla and J. John (Czechoslovak Acad. of Sci., Inst. of Radio Eng. and Electron. and Postgraduate Med. Inst., Dept. of Ophthalmol., Prague).
American Journal of Ophthalmology, vol. 62, Oct. 1966, p. 659–663. 9 refs.

Using a He–Ne gas laser continuously operating at 6328 Å, an analogous dependence between retinal threshold coagulation doses and time exposure was obtained. Measurements were made on gray chinchilla rabbit retinas. For mild lesions the output power of the laser was not sufficient. Therefore, the irreversible spot on the retina becoming evident one min. after exposure was accepted as a standard for the threshold coagulation effect. Threshold values were obtained by averaging four or five exposures at the same output power and at different exposure times, and vice versa. The measurements suggested that retinal coagulation is possible with medium-power gas lasers. One min. after exposure a fine edematous spot was observed on the retina. The lesions produced above threshold demonstrated more marked gray–yellow spots, most of which were craterlike. The relation between power (energy) and exposure time measured by the He–Ne laser was plotted, and from the curve it was evident that for diameters of image sizes less than 100μ, a saturation effect takes place between incident energy and exposure time. For image diameters around 70 μ a saturation threshold energy density of approximately 45 J./cm^2 was obtained.

A67-80670
THRESHOLD LESIONS IN RABBIT RETINAS EXPOSED TO PULSED RUBY LASER RADIATION.
A. Kohtiao, I. Resnick, J. Newton, and H. Schwell (N. Y. Eye and Ear Infirmary, Res. Dept., New York City).
American Journal of Ophthalmology, vol. 62, Oct. 1966, p. 664–669. 10 refs.
John A. Hartford Found. supported research.

A total of 160 exposures on the retinas of 41 rabbits were made with the regular pulsed ruby laser and 152 exposures on 32 rabbits were made with the Q-switched laser. After each exposure of the retina to laser beam the lesion site was examined immediately and at intervals of five min., one hr., 24 hr. and every 24 hr. thereafter. Near threshold the lesion size was about 0.2 mm. A histologic section of a near threshold lesion 48 hr after exposure to the Q-switched laser revealed some dissolution of the rods and cones centrally and a condensation of the pigment epithelium. Also there was choroidal round-cell infiltration. No gross microscopic changes were noted in the upper retinal layers. The general features of the lesions produced by both types of lasers were similar. It was evident, however, that equal energy from the regular pulsed ruby laser and from the Q-switched laser did not produce equal effects. The Q-switched laser required 40 times less energy to produce a lesion as did the regular pulsed laser. The Q-switched pulses were about 80 nanoseconds in duration whereas the regular pulsed laser was about 0.5 milliseconds in duration.

A67-80691
SOME EFFECTS OF NEODYMIUM LASER RADIATION UPON THE HEADS OF DOGS.
Kenneth M. Earle, F. M. Garner, Keith L. Kraner (Armed Forces Inst. of Pathol., Washington, D. C.), William B. McKnight (U.S. Army Missile Command, Directorate of Res. and Develop., Electromagnetics Lab., Appl. Phys. Branch, Redstone Arsenal, Ala.), and James R. Dearman.
Military Medicine, vol. 132, Feb. 1967, p. 122–127.

Four beagle cross dogs were exposed to single focused and unfocused shots of neodymium laser radiation directed upon their shaved foreheads. The energy of the shots on target were as follows: (1) 610 joules unfocused over an area about one cm. in diameter, (2) 490 joules focused over an area about two mm. in diameter, (3) 800 joules unfocused over an area about one cm. in diameter, (4) 610 joules focused over an area about two mm. in diameter. The sequence of events was studied by high speed movies (up to 7000 frames/sec.), by regular speed movies, and by closed circuit television. On television the heads of the dogs appeared to move as a direct result of the shot, but high speed photographs revealed that the movement came approximately 0.1 second after the shot. The movement of the head came after the burning off period had completely cleared and could not have been due to any explosive, rocket-like, or other propulsive effect. The time interval is compatible with reaction to startle or pain. The dogs appeared normal after the shots with no evidence of concussion. Two dogs were observed for three months after the shots and two dogs were observed for six months. Autopsy revealed superficial scarring of skin with failure of hair to re-grow at the sites of the initial burns. The skull, dura, and brain of each dog showed no evidence of damage from the laser radiation on gross or microscopic examination.

A67-80782
APPARENT SIZE AND HUE VARIATIONS OF A LASER LIGHT SPOT.
H. John Caulfield (Tex. Instr. Inc., Dallas).
Human Factors, vol. 8, Oct. 1966, p. 435–440. 9 refs.

Both the apparent size and the apparent hue of a single spot of 6328 Å laser light vary with varying conditions, and with the particular observer. The apparent radius of a spot can vary from zero to several times the objectively-determined radius as the background lighting conditions are changed. The general features of this variation are predictable theoretically. The apparent hue of the center of a laser spot can shift as much as 340 Å. Previous theory for the hue shift is shown to be inadequate, but no fully adequate theory is suggested.

A67-81344
THE C. W. LASER, AS A STIMULATOR IN ELECTRORETINOGRAPHY.
Giovanni Del Signore.
Atti della Fondazione Giorgio Ronchi e Contributi della' Istituto Nazionale di Ottica, vol. 22, Mar.–Apr. 1967, p. 190–194. In Italian.
Contract USAF F6 1052 C 0067.

In vivo electroretinographic responses are difficult to obtain from a small retinal area when using conventional light sources due to scattered light, which also excites the receptors that are outside the focal area. One solution to this problem might be the use of a continuous wave laser as a light source for the stimulator. Its main advantage is provision of an extremely narrow beam (0.5 mm. or less in diameter, at the pupil) of coherent and monochromatic light greatly decreasing the number of diffusing cells and molecules in the path of the light source. Sizeable extrafoveal responses were recorded only at the maximum intensity used which agrees with the view that the laser beam excites only the cones. Some data were given for comparison of records using the laser and using white light (incandescent lamp).

A67-81660
EVALUATION OF THE MECHANISM OF SOME PHYSICAL EFFECTS OF LASERS ON TISSUE.
Janice A. Mendelson, Norman D. Cook, and James R. Dearman (U.S. Army Missile Systems Command, Electromagnetics Lab., Appl. Physics Branch, Redstone Arsenal, Ala. and Res. Labs., Biophys. Lab., Trauma Invest. Dept., Edgewood Arsenal, Md.).
Military Medicine, vol. 132, Apr. 1967, p. 270 281. 28 refs.

A discussion as well as some experimental evidence was presented on the physical properties and mechanisms of damage of lasers on biological material. The skin and subcutaneous tissues of Duroc hogs and the skin of a dairy goat as well as part of a human skull were exposed to laser energies of 410 to 735 joules. There was not evidence of gross damage to the tissues. A discussion considered parameters of laser beams which might be injurious. These factors included thermal effects and the possible formation of a pressure wave by the laser. A review of papers dealing with morphological and physiological changes pointed out various aspects of injury. With the exception of the eyes it is concluded that there is no likelihood of other than superficial damage from accidental exposure of man and animals to lasers.

A67-81799
ABERRANT CORNEAL EPITHELIAL CELLS PRODUCED BY RUBY LASER IRRADIATION.
W. H. Parr and Robert S. Fisher (U.S. Army Med. Res. Lab., Biophys. Div., Fort Knox, Ky.).
Investigative Ophthalmology, vol. 6, Aug. 1967, p. 356 363. 15 refs.

Ruby laser radiation (6,943Å) produced aberrations in the corneal epithelium of the rat. At 4 joules/cm.^{2} aberrant corneal epithelial cells became apparent immediately after laser irradiation and some were still present 30 days later. At 8 joules/cm.^{2} twice as many or more atypical cells were found. The mechanism by which laser radiation alters the cornea remains obscure.

A67-81815
LASER RADIATION. II. LONG-TERM EFFECTS OF LASER RADIATION ON CERTAIN INTRACRANIAL STRUCTURES.
Thomas E. Brown, Charles True, Robert L. McLaurin, R. James Rockwell, Jr., and Peter Hornby (Cincinnati, U.; Cincinnati Gen. Hosp.; and Children's Hosp. Res. Found., Cincinnati, Ohio).
Neurology, vol. 17, Aug. 1967, p. 789–796. 10 refs.
John A. Hartford Found. supported research.

Long-term clinical and pathologic studies were described for up to one month after laser irradiation of certain intracranial structures after direct surgical exposure of the cerebral cortex, the pituitary gland, and the optic and oculomotor nerves. Surface-focused and convergent laser beams with energy levels from 10 to 40 joules were delivered by a liquid nitrogen-cooled ruby-pulsed laser. Results showed that (1) neural damage caused by laser energy is irreversible, (2) the healing mechanism of laser-damaged neural tissue is altered because astrocytosis is delayed, and (3) neurons are quite susceptible to laser irradiation effects, whereas astrocytes are relatively resistant. A specific difference in cell affinity to laser energy may be responsible for this, although local anoxia from the vascular damage remains a possibility. Myelinated structures, subcortical white matter, neurohypophysis, and optic and oculomotor nerves show less injury than does highly cellular tissue (cerebral cortex, anterior hypophysis) at similar energy levels. Laser-induced damage was confined to the immediate site of impact. Distant brain damage was not seen.

A67-81949
PRELIMINARY OBSERVATIONS ON OCULAR EFFECTS OF HIGH-POWER, CONTINUOUS CO_2 LASER IRRADIATION.
Ben S. Fine (Armed Forces Inst. of Pathol., Ophthalmic Pathol. Branch, Washington, D. C.), S. Fine, George R. Peacock (Northeastern U., Dept. of Biophys. and Bio-Med. Eng., Boston, Mass.), Walter J. Geeraets (Depts. of Ophthalmol. and Biophys., Richmond, Va.), and Edmund Klein (Roswell Park Mem. Inst., Buffalo, N. Y.).
American Journal of Ophthalmology, vol. 64, Aug. 1967, p. 209–222. 9 refs.
Contracts DA-49-193-MD-2680, DA-49-193-MD-2436, DA-49-146-XZ-102 and Grants PHS NB-05575-03, PHS R01-RH-00361.

The various ocular changes that occur in experimental pigmented rabbit eyes subjected to laser irradiation at 10.6 μ were evaluated clinically, grossly and histopathologically. Corneal thickening and central crater formation occurred that, at high-power levels, penetrated into the anterior chamber, along with ejection of an aqueous stream. Thickened cornea consisted of both "fused" and nonfused lamellae. Some of the lesions that did not penetrate into the eye were accompanied by a depression of the anterior lens surface, apparently a result of heat transmission. Deeper intraocular changes did not occur in the nonpenetrated eye within the limited time interval between irradiation and these preliminary observations. A clear plastic face shield 0.060 in. thick was found to be an effective protection to the eye under the limited conditions of these experiments. This shield may also serve as an indicator of accidental exposure.

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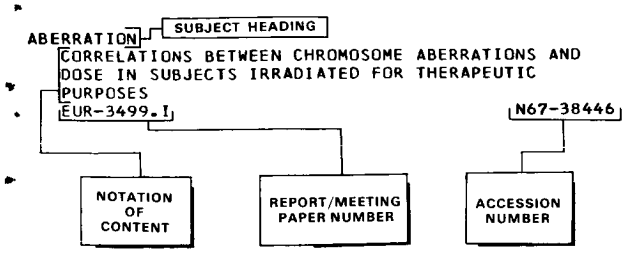
Typical Subject Index Listing



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A

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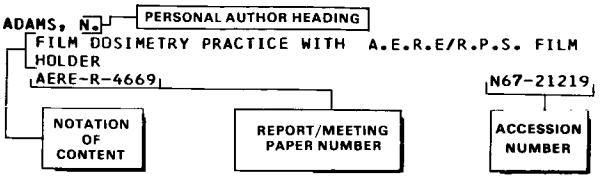

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